**Research article**

# Assessment of neuromuscular monitoring in obese patients with abdominal interventions

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## ABSTRACT

**Introduction and Aim:** In 2010, it was estimated that there were 500 million obese people and 1.4 billion overweight people in the world. This study seeks to assess an approach for neuromuscular monitoring in obese patients with abdominal interventions.

**Materials and Methods:** The patients were between the ages of 18 and 56, with a mean age of 37.0 years. Out of the 34 patients, 15 (45%) were males and 19 (55%) were females. All patients were categorized into two groups: Group 1 includes 21 patients with a normal body mass index, and Group 2 includes 13 patients with a body mass index ranging from 30.1 to 40.0 or higher.

**Results:** People in group 1 who responded to T2 and T3 in the Train of Four-stimulation mode were given Sugammadex at a dose of 2 mg/kg, which is 205.90 mg. In group 2, the recovery of neuromuscular blockade (NMB) occurred independently. The time between the last dose of rocuronium and the end of the breathing tube was 48.00 minutes in group 1 and 64.91 minutes in group 2. This showed that patients in group 1 recovered from NMB statistically significantly faster (t = -4.636).

**Conclusion:** In obese patients, it is especially important to restore the NMB quickly and completely after surgery.

**Keywords:** Obesity; body mass index; necrosis; neurons; glial cells.

## INTRODUCTION

The American Heart Association reports that 17% of young Americans (2–19 years old) and almost one-third of American adults are obese. In 2010, it was estimated that there were 500 million obese people and 1.4 billion overweight people in the world. Every age group, gender, ethnicity, and smoking have been impacted by this increase (1-3). A body mass index (BMI) of more than 30 kg/m2 is associated with a considerably higher risk of death (4,5). In individuals with a BMI of >40 kg/m2, mortality is seen to increase six times in the 35–45 age group and twelve times in the 25–30 age group compared to those of the same age who are not obese (Fig. 1).

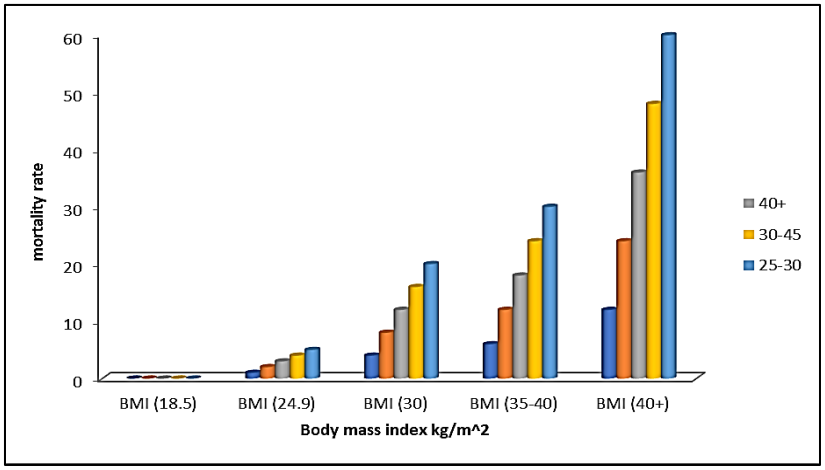


**Fig. 1:** Frequency of association between mortality and BMI in different age groups

Over the years, strong evidence has emerged in favor of surgery for obesity and weight-related diseases as a treatment option (6). Cardiovascular disease and non-alcoholic fatty liver disease are two chronic illnesses that have been associated with a high BMI. Chronic renal disease, musculoskeletal disorders, diabetes, various cancers, mental health disorders, and musculoskeletal diseases all lower quality of life and raise healthcare costs (7). Varicose veins in the lower extremities are observed in 31-38% of obese

individuals (8). During the perioperative phase, obese individuals require a distinctive strategy. When compared to patients who are not obese, they are at a higher risk.

The safety, efficacy, and outcome of surgical treatment for overweight patients are greatly impacted by the timely and extensive elimination of residual neuromuscular blockade (NMB) following the different stages of anesthesia and surgery, as well as by the proper control of muscle relaxation during these stages (9, 10). It is crucial to keep muscles relaxed during surgery in order to ensure the lungs are receiving enough air. Patients who are obese are four times more likely to suffer from postoperative pulmonary problems compared to individuals who have a normal body weight (11).

Overweight causes metabolic syndrome, venous thrombosis, obstructive sleep apnea, respiratory failure, and diaphragmatic hernia (DH), as well as slowing down the passage of food from the stomach, increasing the volume of the stomach, and raising the acidity of the digestive tract (12). It also affects the conduction of excitation impulses in the myocardium, causes the development of rhythm disturbances, and increases cardiac output (100 ml/min per kilogram of excess body weight). Hypoxemia, alterations in lung volume, and respiratory testing are associated with obesity. The ventilation response to CO2 is clearly reduced in 5–10% of cases (13). This study seeks to assess an approach for neuromuscular monitoring in obese patients with abdominal interventions.

## MATERIALS AND METHODS

This study included 34 patients hospitalized by the Department of Surgery of the Emergency Medicine Hospital with obesity during abdominal procedures (hernia). The patients were between the ages of 18 and 56, with a mean age of 37.0±3.0 years. Out of the 34 patients, 15 (45%) were males and 19 (55%) were females.

All patients were categorized into two groups: Group 1 includes 21 patients with a normal BMI, and Group 2 includes 13 patients with a BMI ranging from 30.1 to 40.0 or higher (Fig. 2). With the use of muscle relaxants and perioperative objective monitoring of NMB, all patients received traditional anesthesia.

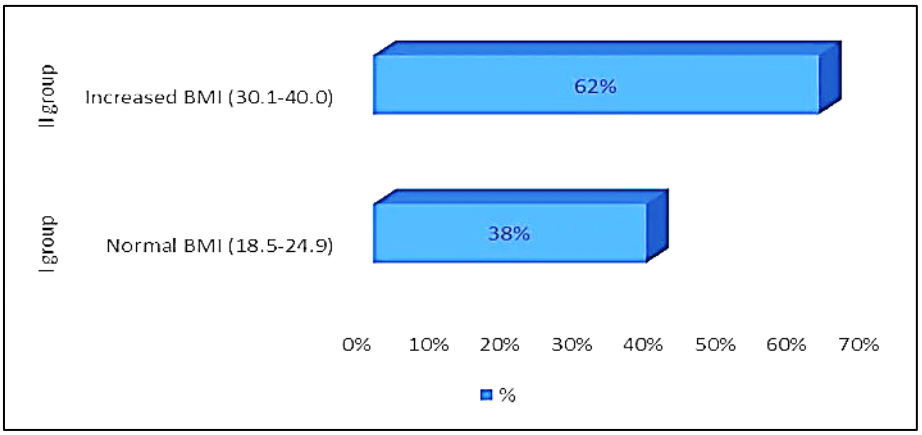


**Fig. 2:** Distribution of patients with obesity into two groups according to normal and increased BMI

Fentanyl and propofol were mixed with muscle relaxants like Suxamethonium before the surgery or a high dose (up to 1.2 mg/kg) of rocuronium to start the procedure quickly. This dose of rocuronium acts for up to one hour, causing deep myoplegia for one minute. By continuously infusing a maintenance dosage of a muscle relaxant or by fractionally administering bolus doses, one can maintain muscular relaxation.

Muscle relaxants with an average duration of action often have a bolus maintenance dosage of little more than 25% of the intubation dose. Depending on the anesthetic, the requirement for any muscle relaxants was decreased by 20% or more when inhaled anesthetics were present.

Stimulation of the ulnar nerve in the distal third of the forearm and measurement of the contraction of the muscle that leads to the hand's thumb were used to evaluate neuromuscular function.

The Train of Four (TOF) test consists of four sequential electrical stimuli at a frequency of 2 hertz (Hz).

1. In the distal portion of the forearm, on dry, fat-free skin, ECG-electrodes have been placed on the ulnar nerve's projection.
2. The thumb pad is where the sensor is positioned so that the finger's vector of movement, from the point to the brush, is perpendicular to the sensor area.
3. The hand and 2–5 fingers of the hand are fixed so as not to obstruct the thumb's natural motion.
4. Following the induction of anesthesia, the monitor is turned on (current strength: 50 mA).
5. Following calibration, a muscle relaxant was administered and TOF was measured.

When the muscles are relaxed and under anesthesia, a monitor can be connected to track the restoration of neuromuscular transmission.

Statistica v8.0 (StatSoft Inc., Tulsa, USA) was used for the statistical analysis. The acquired information is shown as n (%) and mean±standard deviation. To evaluate parameter differences, the Student's t test was used. At $p < 0.05$, differences were considered statistically significant. The National Surgical Center named after academician M.M. Mamakeev's Bioethics Committee (Protocol No. 14, dated May 12, 2022), approved the study and maintained the confidentiality of the collected data.

## RESULTS

People in group 1 who responded to T2 and T3 in the TOF-stimulation mode were given Sugammadex at a dose of 2 mg/kg, which is 205.90±11.14 mg. Complete reversal of the NMB (TOF index ≥ 90%) occurred 62.91±13.35s after administration of Sugammadex. In group 2, the recovery of NMB occurred independently. All patients with a TOF index of more than 90% were able to use all of their muscles again after the endotracheal tube was taken out. This included a clear cough reflex, the ability to swallow, good spontaneous ventilation, head retention for more than five seconds, and good speech contact. The time between the last dose of rocuronium and the end of the breathing tube was 48.00±12.82 minutes in group 1 and 64.91±4.68 minutes in group 2. This showed that patients in group 1 recovered from NMB statistically significantly faster ($t = -4.636$; $p<0.0001$). There were no signs of a recurrence of the NMB. When quantitatively comparing the actual doses obtained calculated for the ideal weight for these patients, no excess of the threshold of 1.2 mg/kg of ideal weight was recorded. There were no serious side effects associated with the use of the drug Sugammadex. In group 1, the recovery stages after the deep block level (T0-T2) before tracheal extubation (TOF 90%) took 25±15 minutes, 99% of the time, with no cases of NMB.

Among the most common surgical procedures are those involving the abdominal organs and performed by laparotomy. For such procedures, the surgeon has to achieve ideal muscular relaxation, and the anesthesiologist must provide optimal muscle relaxation. A deep blockage is necessary to enable surgical manipulations through muscle arrays in difficult-to-reach parts of the body, particularly in surgeries on the upper floor of the abdominal cavity. From the time of the laparotomy to the suturing of the aponeurosis, adequate myoplegia is required during the entire procedure. To obtain and maintain an ideal level of muscular relaxation during abdominal organ surgery, it is advisable to focus on the TOF T0-T1 signs, intensifying the block in the case of diaphragm contractions. They also confirm the need to maintain deep NMB throughout the operation, until the end result, when hemostasis, revision, and abdominal cavity draining are carried out. The study findings indicate that in 11 to 20% of cases at different phases of the surgery, phenomena such as diaphragmatic contractions, intestinal loops bursting into a laparotomy site, and patient movements of the limbs and head were observed.

An increase in respiratory tract pressure was observed in 22% of cases, and the use of an overcalculated dosage of a muscle relaxant was necessary in 26% of cases. While anesthesiologists do not observe this relationship, 38% of surgeons consider there is a direct correlation between the patient's inability to relax their muscles during surgery and the emergence of complications. Anesthesiologists (83%) and surgeons (72%) accept that longer surgeries result from inadequate NMB. Many anesthesiologists refuse to maintain deep muscular relaxation since doing so naturally delays the timing of extubation when muscle relaxants are introduced towards the last stage of the procedure. The rejection of deep-induced myoplegia during the later stages of surgery, which does not increase patient safety, also worsens the surgeon's working conditions when suturing the laparotomy and wound.

## DISCUSSION

In order to attain and preserve the highest possible degree of muscular relaxation during abdominal organ surgery, attention should be paid to TOF T0-T1 signs. Because the structures being worked on are deep, the diaphragm is close by, there is a lot of reflexogenicity, and quick movements by the patient could damage the surgical instruments, it is especially important to relax the muscles during procedures on the organs on the upper floor of the abdominal cavity. Despite all the challenges, complete restoration of neuromuscular transmission in the patient is required if there are no signs of continued breathing at the end of anesthesia. Any non-depolarizing muscle relaxant used before has a 10-85% probability of causing enduring curarization. Breathing problems can worsen the early postoperative period even in cases with subclinical NMB, which is difficult to diagnose without specialized tools, especially in patients who are already at risk.

Hypoxemia, variations in lung volume, and respiratory examinations are associated with obesity. The ventilation response to $CO_2$ is reduced in 5–10% of cases (13). It is now feasible to simplify and improve patient safety while working with this aspect of anesthesia because of the widespread use of contemporary muscle relaxants that have an improved pharmacokinetic profile (14). However, full control of NMB is not possible with current muscle relaxants. Depending on the circumstances on the operating table during surgery for obese patients, it would be possible

to rapidly and accurately adjust the depth of NMB, leading to significant relaxation (15, 16). Patients who are obese are four times more likely than those who have a normal body weight to suffer postoperative pulmonary problems (17, 18). Bronchospasm, laryngospasm, desaturation, aspiration, and pneumothorax are the most common causes (19). Obese individuals also have a higher risk of breathing problems and tracheal intubation; greater caution and planning need to be taken (20).

Even though many diets have the potential to be beneficial, several studies suggest that concentrating on a specific macronutrient is not required to lose weight.

The Mediterranean diet exceeded a low-fat diet in preventing major cardiovascular events, such as myocardial infarction, ischemic stroke, peripheral arterial disease, and cardiac death rates, according to a 7-year follow-up study (21). Numerous studies show that using a Mediterranean diet could result in long-term and short-term weight loss (22). A ketogenic diet has been demonstrated to be beneficial for several diseases, such as cancer, high cholesterol, epilepsy, cardiovascular disease, and type 2 diabetes (23, 24). Increased ghrelin levels, lower concentrations of satiety peptides (glucagon-like peptide-1, cholecystokinin), increased appetite, and decreased satiety are all consequences of diet-induced weight reduction. Some of these reactions are reduced by a ketogenic diet (25). Studies have demonstrated that omega-3 fatty acid supplementation can effectively cure a number of illnesses, including diabetes, cancer, heart disease, and inflammation (25–28). According to a comprehensive study, there is evidence that supplementing with omega-3 fatty acids helps with weight reduction or reduces body fat mass (29).

## CONCLUSION

In obese patients, it is especially important to quickly and completely restore the NMB after surgery. It is recommended to carry out the restoration of NMB under the control of objective monitoring to assess the effectiveness of decurarization and the absence of residual NMB. Clinical signs of NMP recovery are not always reliable. The optimal method for an objective assessment of the state of NMP, especially for making a decision on extubation, is monitoring the response to TOF stimulation. The safety criterion should be considered a TOF ratio of at least 0.9 (90%). The widespread use of objective quantitative monitoring of NMB will allow practical anesthesiologists to assess the severity of the problem of control on NMB induced by muscle relaxants.

## CONFLICT OF INTEREST

The authors have no conflicts of interest.

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