Commentary
Volume 9: 01, 2025

Journal of Clinical Anesthesiology: Open Access

ISSN: 2684-6004

Open Access

Revisiting Muscle Relaxant Dosing in Bariatric Surgery Anesthesia

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Introduction

Bariatric surgery presents a complex anesthetic challenge, particularly in the dosing and management Of Neuromuscular Blocking Agents (NMBAs). The pharmacokinetics and pharmacodynamics of muscle relaxants are significantly altered in obese patients due to increased adipose tissue, changes in lean body mass, altered drug distribution and variations in organ function. Traditionally, Total Body Weight (TBW) was often used for dosing NMBAs, leading to concerns about overdosing, prolonged neuromuscular blockade and delayed recovery. Contemporary evidence suggests that a more nuanced approach is necessary, utilizing Ideal Body Weight (IBW), lean body weight (LBW), or adjusted body weight (ABW) depending on the specific agent and surgical context. For instance, non-depolarizing NMBAs like rocuronium are generally dosed based on IBW or LBW to avoid excessive drug accumulation, whereas depolarizing agents like succinylcholine are more appropriately dosed using TBW due to increased pseudocholinesterase activity in obese individuals. This distinction is critical in bariatric patients, who are at increased risk for difficult intubation, aspiration and postoperative respiratory compromise [1].

Description

The use of quantitative neuromuscular monitoring has become essential in guiding both the dosing and reversal of muscle relaxants in this population. Proper monitoring can help tailor the depth of blockade, avoid residual paralysis and improve patient outcomes, especially in procedures requiring deep or prolonged paralysis. Pharmacologic reversal agents such as sugammadex have revolutionized NMBA management, allowing rapid and reliable reversal of aminosteroid NMBAs like rocuronium, even after high-dose administration. However, dosing of reversal agents must also account for patient weight and depth of blockade to be effective and safe. The development of evidence-based dosing algorithms is crucial to standardizing care and minimizing complications. Anesthesiologists managing bariatric surgery must balance adequate muscle relaxation with prompt recovery and respiratory safety [2].

Understanding the physiological alterations in obesity is key to optimizing NMBA use during bariatric anesthesia. Increased cardiac output and altered regional blood flow can affect drug distribution and elimination, leading to variable onset and duration of action. For example, vecuronium and atracurium may demonstrate prolonged effects due to slower redistribution and metabolism in obese patients, especially when dosed improperly. Furthermore, the volume of distribution of lipophilic agents may be expanded in these individuals, necessitating dosing adjustments to achieve the desired pharmacologic effect without increasing risk. Obesity-related hypoventilation, obstructive sleep apnea and reduced functional residual capacity further complicate anesthetic management, increasing sensitivity to residual neuromuscular blockade. The risk of postoperative pulmonary complications, including hypoxia, atelectasis and aspiration, makes full reversal of paralysis and extubation readiness essential components of safe care. Quantitative neuromuscular monitoring, particularly acceleromyography or electromyography, should be standard in all bariatric cases to assess recovery accurately and guide timing of extubation. The practice of relying solely on clinical signs, such as head lift or tidal volume, is insufficient in this patient group and may underestimate residual blockade. In cases requiring rapid sequence induction, succinylcholine remains widely used due to its fast onset; however, appropriate TBW-based dosing and awareness of potential hyperkalemia are important considerations. Rocuronium, paired with sugammadex for rapid reversal, offers an alternative with a more favorable safety profile in select patients. Ultimately, individualized NMBA dosing strategies that incorporate physiologic, pharmacologic and surgical factors can reduce perioperative morbidity and enhance recovery. These approaches reflect a growing consensus that precision dosing and vigilant monitoring are essential in bariatric anesthesia [3].

Intraoperative management of muscle relaxation in bariatric patients requires careful coordination with the surgical team to achieve optimal operating conditions while avoiding excessive depth or duration of blockade. Many bariatric procedures, particularly laparoscopic sleeve gastrectomy or Roux-en-Y gastric bypass, require profound relaxation to facilitate abdominal insufflation and visualization. Deep neuromuscular blockade (DNB) can enhance surgical conditions and potentially reduce the need for higher insufflation pressures, thereby minimizing the adverse effects of pneumoperitoneum on cardiovascular and respiratory function. However, DNB must be used judiciously, with the anesthesiologist prepared to monitor and reverse the blockade fully prior to emergence. The use of high-dose rocuronium, guided by train-of-four (TOF) and post-tetanic count (PTC) monitoring, allows titration to surgical needs while maintaining patient safety. Sugammadex, when administered at appropriate doses based on the depth of blockade and ABW, can reliably reverse even deep levels of paralysis within minutes. Fluid shifts, acidosis and temperature changes during prolonged surgery can also affect drug metabolism, further justifying the need for dynamic intraoperative monitoring. The anesthetic plan should include contingency strategies for difficult airway management, delayed emergence and postoperative respiratory support if needed. The integration of pharmacologic precision, surgical coordination and technology-driven monitoring defines best practices in modern bariatric anesthesia [4].

Current trends emphasize enhanced recovery pathways (ERAS), where rapid emergence, minimal drug accumulation and reduced opioid use are prioritized. Tailoring NMBA and reversal agent dosing to support these goals requires a departure from traditional weight-based heuristics and a shift toward individualized, data-driven care. Institutional protocols should incorporate contemporary evidence regarding LBW and ABW-based dosing for non-depolarizing agents, as well as clear guidance on neuromuscular monitoring standards. Education and simulation-based training can improve anesthesiologist confidence and competence in managing high-BMI patients, particularly in emergency scenarios. Cost considerations, especially regarding sugammadex, must be balanced against the potential for reduced PACU time, fewer respiratory complications and shorter hospital stays. Future research should aim to refine dosing models using pharmacokinetic simulations,

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Received: 01 February, 2025, Manuscript No. jcao-25-168877; **Editor Assigned:** 03 February, 2025, PreQC No. P-168877; **Reviewed:** 15 February, 2025, QC No. Q-168877; **Revised:** 22 February, 2025, Manuscript No. R-168877; **Published:** 28 February, 2025, DOI: 10.37421/2684-6004.2025.9.280

explore outcomes related to DNB in laparoscopic surgery and assess the impact of monitoring adherence on patient safety. Additionally, efforts to develop smart infusion pumps or closed-loop NMBA delivery systems may enhance dosing accuracy and reduce provider burden [5].

Conclusion

As personalized medicine gains traction in anesthesiology, genomic or metabolic profiling could further inform optimal drug choices and dosing strategies for obese patients. The overarching goal remains consistent: to ensure safe, effective and patient-centered anesthesia care that supports both surgical success and postoperative recovery. Revisiting and modernizing muscle relaxant dosing in bariatric surgery is not merely a pharmacologic issue—it is a critical step toward advancing perioperative care for a growing patient demographic. With continued research, collaboration and education, anesthesiologists can meet the demands of bariatric anesthesia with greater precision and confidence.

Acknowledgment

None.

Conflict of Interest

None.

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How to cite this article: Zehn, Oriya. "Revisiting Muscle Relaxant Dosing in Bariatric Surgery Anesthesia." *J Clin Anesthesiol* 9 (2025): 280.