Use of muscle relaxants in patients with difficult airway – Are we burning the bridge behind us?

Much has been written in the literature regarding the use of succinylcholine, particularly in the setting of rapid sequence induction and intubation (RSI & I). The use of succinylcholine, introduced into clinical practice 60 years ago, has remained the main-stay for RSI & I because of several important and relatively unique properties: 1) it is relatively weak as a depolarizing agent (the dose required for depression of twitch height by 95%, or ED95, is 0.25-0.3 mg/kg), so relatively large doses (1-1.5 mg/kg, or the equivalent of 3-5 times ED95) are administered for rapid onset of complete muscle paralysis; 2) the onset of action is the fastest of any muscle relaxant (40-60 sec); 3) the reliability of paralysis is also among the best (in other words, the mean onset time has the narrowest standard deviation of any muscle relaxant and the fewest outliers); and 4) it has the shortest clinical duration (7-11 min, depending on the total dose administered) of any other muscle relaxant.

In a recent article published in *Anesthesiology*, Ikeda et al [1] elegantly demonstrated that in patients with an apparently normal airway anatomy, succinylcholine may have an additional salutary effect: it significantly increased total tidal volumes during mask ventilation, as compared to patients ventilated by a facemask after receiving rocuronium. The authors explained this improvement in tidal volume by the dilation of the space at the isthmus of the fauces, observed endoscopically during pharyngeal fasciculations in six of the subjects who received succinylcholine. The article is accompanied by an Editorial View in the journal *Anesthesiology*, written by Richardson and Litman [2]. The authors of the Editorial View emphasize that changes of well-established airway management routines should be introduced into the clinical practice slowly and be based on scientific evidence. We could not agree more.

What we would like to point out, however, is a statement of the authors of the Editorial View in *Anesthesiology* that might be misconstrued (or worse, misapplied clinically): “Administering succinylcholine instead of the preferred nondepolarizing agent may improve mask ventilation, yet preserve the option to ‘wake the patient up’ if needed.”

The use of a short-acting muscle relaxant such as succinylcholine, in the hopes of retaining the option for quick recovery of spontaneous ventilation in case of the development of a “cannot ventilate/cannot intubate” (CVCI) scenario appears controversial at best, and clinically unsafe, at worst. In an experimental study, Benumof et al [3] have reported that critical hemoglobin desaturation (defined as $\text{SpO}_2 = 80\%$) in a “healthy 70-kg adult, a moderately ill 70-kg adult, a healthy 10-kg child, and an obese 127-kg adult” will be reached after a mean of 8.7, 5.5, 3.7, and 3.1 min, respectively. In the same report, average times until 60% desaturation in these 4 patient groups required 9.9, 6.2, 4.3, and 3.8 min, respectively [3]. As Benumof concludes, the mean functional recovery duration (defined as return of control twitch height to 50% of baseline, when patients are likely to start breathing spontaneously – IF NO other anesthetics are administered to further depress the respiratory drive) after this dose of succinylcholine is 8.5 min. In the best-case scenario, then, if no other respiratory depressant medications (such as benzodiazepines, opioids, or anesthesia induction agents) were administered, AND if the patient had undergone complete alveolar denitrogenation, AND if the actual dose of succinylcholine were only 1 mg/kg, AND if the patient were not a slow succinylcholine-metabolizer or had pseudocholinesterase deficiency, then the 70-kg healthy patient would resume spontaneous ventilation after 8.5 min. However, the 10-kg child, the obese 127-kg adult, and the moderately ill 70-kg patient would be “either profoundly hypoxemic or, in all likelihood, dead at this
Difficult mask ventilation, either predicted before or encountered after induction of anesthesia, should be considered as one of the manifestations of the difficult airway [6]. Difficult or impossible mask ventilation occurs with a surprisingly high frequency, and one of the main risk factors for difficult mask ventilation is obesity [7, 8]. Although difficult mask ventilation is not necessarily accompanied by difficult intubation [7-9], the two may occur together, despite a normal-appearing airway anatomy. Anesthesia and muscle relaxant administration, especially in obese patients, may be followed by collapse of the upper airway, which may render mask ventilation difficult and might impair the view of the larynx during laryngoscopy. Therefore, despite the findings by Ikeda et al [1] that succinylcholine may improve mask ventilation, easy mask ventilation does not necessarily portend or guarantee successful tracheal intubation. Furthermore, repeated intubation attempts may gradually worsen mask ventilation and can lead to a CICV scenario. We should note that despite describing an interesting clinical finding, Ikeda et al have included in their study only a very small number (n = 31) of patients. Therefore, they may not be representative of all patient populations, especially those with possible difficult airway, such as the morbidly obese patients.

With regard to overweight patients, we should note that a further problem with the administration of succinylcholine as compared with rocuronium for RSI & I is the tendency for more rapid desaturation following succinylcholine as compared to rocuronium [10]. The authors of this article found that the safe apnea time (i.e., time until desaturation to 92%) was significantly shorter after succinylcholine than after rocuronium (283 s vs. 329 s), and the recovery period to 97% saturation after beginning of ventilation was longer after succinylcholine as compared to rocuronium (48 s vs. 36 s) [10]. This difference may be attributed to the increased muscle oxygen consumption induced by succinylcholine-related skeletal muscle fasciculations [11]. Furthermore, although the reduction of succinylcholine dose from 1 mg/kg to 0.56 mg/kg decreased the incidence of apnea-induced desaturation, it did not shorten the time to spontaneous diaphragmatic movement [12]. Naguib et al [12] therefore concluded that a significant fraction of patients would be at risk of hypoxia if there were failure to intubate and ventilate regardless of the dose of succinylcholine administered.

Another limitation of the findings noted in Ikeda’s study was the lack of a control group of patients who did not receive muscle relaxants; instead, the authors compared succinylcholine with rocuronium. This limits the ability to determine the effects of succinylcholine (or rocuronium) on the normal airway musculature, since no control was used. Thus, we are left without important information regarding the behaviour of the isthmus (and the effects on the ease of mask ventilation) in patients who received no muscle relaxants. The literature, however, does provide some helpful information: in a group of randomly chosen patients (not necessarily all whom had normal airway anatomy), Warters et al [9] tried to answer this question by comparing mask ventilation in 90 patients allocated to two groups: patients who received rocuronium vs. those who received saline (as the control). The authors found that mask ventilation improved significantly after rocuronium administration compared with the patients who received no muscle relaxation. In the Discussion section of their article, Warters et al conclude that since neuromuscular blockade may facilitate tracheal intubation [9], their data further indicate that neuromuscular blockade facilitates mask ventilation and therefore the authors consider neuromuscular blockade an advantage, rather than a hindrance, when given early in a case of unrecognized difficult mask ventilation. We tend to agree with Warters et al, provided there are no signs heralding a difficult intubation, a situation in which we advise withholding the administration of the muscle relaxant.

With the new era of clinical use of sugammadex, a drug that provides full reversal of the effects of the aminosteroid muscle relaxants (among them rocuronium) in a matter of 2-3 minutes after the administration of a full dose of relaxant [13, 14], one would be tempted to routinely use rocuronium instead of succinylcholine, in the knowledge that the effects of rocuronium might be reversed completely and rapidly, should tracheal intubation prove impossible. Alternatively, the clinician might be emboldened by the availability of sugammadex and proceed with administration of general anesthesia and neuromuscular paralysis (with vecuronium or rocuronium) in a patient with known or suspected difficult airway, rather than proceeding with the more conservative approach of awake fiberoptic intubation.

The fallacy of such practice, however, was highlighted recently in case report [15] in which a patient with predicted difficult airway was managed with full-dose rocuronium at induction of anesthesia, in the hopes that the patient might be brought back to spontaneous ventilation after administration of sugammadex if tracheal intubation were found impossible. Unfortunately, this case report documents that such practice is not based on a realistic expectation, and the patient suffered significant morbidity; since tracheal intubation was found to be impossible and the patient was unable
to regain spontaneous ventilation, an emergent surgical airway had to be performed. Although following sugammadex the patient regained her motor strength, she was still unable to ventilate spontaneously, due to the airway edema created by the repeated attempts at intubation. As the case report’s authors admonish, “the availability of sugammadex does not obviate the need for emergency tracheal access in the event of failed oxygenation” [15]. A safer alternative to the administration of a muscle relaxant (including succinylcholine) in the case of difficult mask ventilation might be oxygenation and ventilation through an extraglottic airway device. This technique may also allow the insertion of an endotracheal tube via the extraglottic device, either directly or under fiberoptic guidance.

Until scientific evidence proves that neuromuscular blockade (with succinylcholine or other agents) is safe in those patients who need to have “improved mask ventilation”, we strongly suggest that the use of succinylcholine “in case we need to wake the patient up” is fraught with too much potential for a disastrous outcome and should not be relied upon in cases of questionable ability to mask ventilate, especially when difficult intubation is suspected. Although we are aware of the fact that administration of muscle relaxants in the presence of difficult mask ventilation remains a controversial issue and that there is no strong scientific evidence to support either approach, we are convinced that when dealing with a potentially difficult airway, the clinician should be careful not to “burn the bridge” to patient safety.

References

3. Benumof JL, Dagg R, Benumof R. Critical hemoglobin desaturation will occur before return to an unparalyzed state following 1 mg/kg intravenous succinylcholine. Anesthesiology 1997; 87: 979-982

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