

EDITORIAL VIEWS

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Intramuscular Rocuronium in Infants and Children—Is There a Need?

In this issue of the Journal, Reynolds *et al.* publish the results of an interesting and well done study on the use of intramuscular rocuronium in pediatric anesthesia. The goal of this study was to develop a technique to facilitate tracheal intubation for children in situations where intravenous access is not immediately available.¹ One could question the need for an alternative to succinylcholine for controlling the airway in children in this situation. The authors justify the study by reference to the recent succinylcholine controversy generated by a change in the package insert in November 1992, wherein the routine use of succinylcholine for intubation in children was contraindicated "except when used for emergency tracheal intubation or in instances where immediate securing of the airway is necessary." The response from the pediatric anesthesia community was so great that the Food and Drug Administration held a meeting in June 1994 that led to a revised package insert dated November 1994. Because children with undiagnosed myopathies who are susceptible to the rare but nonetheless serious consequence of hyperkalemia with succinylcholine developing are usually asymptomatic and have no family history of such susceptibility, the November 1994 package insert states, "since it is difficult to identify which patients are at risk, it is recommended that the use of succinylcholine in children should be reserved for emergency intubation or instances where immediate securing of the airway is necessary, e.g. laryngospasm, difficult airway, full stomach, or for intramuscular use when a suitable vein is inaccessible." This statement leaves the anesthesiologist in an highly uncertain position, and Reynolds *et al.* interpret the statement to mean "these changes in the package insert limit the clinician's ability to give succinylcholine intramuscularly." The authors further state that, "However, concern about succinylcholine's adverse effects has encouraged development of alternative techniques." Therefore, many clinicians are looking for alternate techniques or drugs, and the study by Reynolds *et al.* expands the options for the anesthesiologist.

Another potential problem facing the clinician is the possibility that succinylcholine might disappear from

our practice. It would not surprise me if succinylcholine became unavailable for clinical use because of the medical liability issues. The clinician must be prepared with a plan for using a muscle relaxant that can rapidly be effective after intramuscular injection. An alternative technique to intramuscular relaxants is the use of volatile general anesthetics, such as halothane or sevoflurane, to provide intubating conditions. Yakaitis *et al.* showed that approximately 1.2% end-tidal halothane or 1.3 minimum alveolar concentration is required for children aged 2–6 yr for laryngoscopy and intubation.² However, Reynolds *et al.* are concerned that "breathing the patient down" with an inhalational agent to sufficient levels, to allow intubation, puts the infant at risk for cardiac depression and hypotension.

Reynolds *et al.* were specifically seeking an alternative to intramuscular succinylcholine. The goal would be to find a nondepolarizing muscle relaxant with onset and offset comparable to that of succinylcholine—permitting tracheal intubation in 2.5–3 min and complete recovery in 15–30 min. Intramuscular rocuronium provided the appropriate onset: a dose of 1,000 µg/kg permitted tracheal intubation in infants in 2.5 min, and a dose of 1,800 µg/kg permitted tracheal intubation in children in 3 min. One consideration is that many of the patients in whom tracheal intubation was performed at these time intervals had only "adequate" rather than "good to excellent" intubating conditions. Some of these patients coughed vigorously, something that might be undesirable in certain clinical situations. However, Reynolds *et al.* purposely chose a very light level of anesthesia. With more usual halothane doses, intubating conditions at 2.5–3 min might have been better than observed in this study. One additional issue of concern to the clinician is identifying the time at which tracheal intubation should be attempted. Reynolds *et al.* demonstrate that tracheal intubation can be accomplished well before paralysis of the adductor pollicis is complete, and waiting for complete adductor pollicis twitch depression might delay attempts at tracheal intubation unnecessarily.

Therefore, the data from Reynolds *et al.* document that intramuscular rocuronium is an acceptable alternative as far as elective tracheal intubation is concerned. The drawback to rocuronium is that the time for recovery is

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prolonged: the time to 10% recovery was approximately 72 min in infants and 86 min in children. Such use of intramuscular rocuronium is not suitable for tracheal intubation in elective surgical procedures in infants and children lasting less than 1 h.

An additional use for intramuscular succinylcholine in clinical practice is when laryngospasm, which may or may not be associated with varying degrees of hypoxia, occurs. However, the authors state, "this study provides no insight into the potential for treatment of laryngospasm with intramuscular rocuronium." Hopefully, this drug would be as appropriate as succinylcholine for rapidly establishing the airway when there is airway obstruction due to laryngospasm. This problem cannot be addressed ethically in the clinical laboratory, and such use will need to be defined through anecdotal reports.

The authors also reestablished another important concept for the clinician engaged in pediatric anesthesia. That is, what is the optimal location for the intramuscular administration of medications in situations when an intravenous line is not available? This study initially provided for the intramuscular rocuronium to be given into the quadriceps muscle or the deltoid. With quadriceps injection, the authors discovered that in several children, maximum twitch depression was less than 90%, and that in 5 children, the time to peak twitch depression was greater than 10 min. In contrast, in those infants and children who received injections into the deltoid muscle, twitch depression developed in 100%, a dramatic difference that resulted in the authors' completing the study with only deltoid injections. Intramuscular medications have typically been administered in either the upper extremity (deltoid) or in the lower extremity (quadriceps or gluteus). In studies of the effect of intramuscular succinylcholine, with Sutherland injecting infants in the lower extremity and Liu injecting children in the upper extremity, essentially no difference was found.^{3,*} However, studies in adults demonstrated differences in drug absorption as a function of injection site. For example, with deltoid injections, blood lidocaine concentrations peak earlier and at higher concentrations compared with those after gluteal injections. There are other situations in which absorption from the deltoid should also be exploited.

* Sutherland GA, Bevan JC, Bevan DR: Neuromuscular blockade in infants following intramuscular succinylcholine in two or five per cent concentration. *Canadian Anaesthetist Society Journal* 1983; 30: 342-6.

A study by Zener *et al.*⁴ encouraged this author to suggest the deltoid for the administration of ketamine for the difficult to manage child.⁵ Another is the emergency situation of the child in whom, for whatever reason, there is no intravenous access and who needs epinephrine. Because it has been well documented that intratracheal epinephrine is usually of little benefit, the clinician should consider the deltoid as the site of choice for its intramuscular administration.^{6,7} Perhaps the same could be said for other drugs, such as the urgent need for atropine.

The article by Reynolds *et al.* is of great interest to academicians interested in muscle relaxant pharmacodynamics after intramuscular injection and to clinicians who must expand their options for intramuscularly administered muscle relaxants, because of the unfortunate controversy surrounding succinylcholine. This article also reminds the clinician that the deltoid muscle is the appropriate intramuscular location for medications for rapidity of onset. In the past, there was a search for an alternative to succinylcholine because of its speed of onset after intravenous and intramuscular routes. Now, there will be a search for another non-depolarizing agent with the speed of onset of rocuronium but with the duration of action of that after intramuscular succinylcholine.

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