Succinylcholine and the Open Globe

Tracing the Teaching
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A CURRENT anesthesia text states that “…management of emergency anesthesia for a patient having a full stomach and an open eye injury requires balancing the need to prevent aspiration of gastric contents against prevention of sudden significant increases in IOP [intraocular pressure] that may cause further eye damage and loss of vision.” Referring to a standard technique for the rapid induction of anesthesia (precurarization, thiopental, and succinylcholine), the text also states that “…although IOP may increase with this method, no published reports have described further eye damage after rapid sequence induction of anesthesia with d-tubocurarine, thiopental, and succinylcholine.” Nonetheless, it is a common belief among practitioners that the use of succinylcholine for induction in patients with open globe injuries is relatively or absolutely contraindicated. This belief is based on the known effects of succinylcholine on IOP and the perception that well-documented cases of the extrusion of ocular contents have been reported. Nondepolarizing neuromuscular blocking drugs that duplicate the rapid onset and offset of succinylcholine are not yet available, and this remains a question of clinical relevance for many anesthesiologists. The relative rarity of catastrophic complications such as extrusion of vitreous contents makes it difficult to apply research tools such as randomized clinical trials to guide practice.

In this article, we explore the origins of the teaching that succinylcholine is contraindicated in patients with open eye injuries. It is not our purpose to provide a review of anesthetic effects on IOP but rather to present the history of how this knowledge has been combined with outcome reports to develop clinical recommendations. We believe that this is an instructive example of how clinical recommendations regarding the prevention of low-frequency events in the practice of anesthesia can arise and evolve.

Origins of the Issue

Succinylcholine was introduced to clinical practice in 1952. Foldes et al. announced to the world of anesthesiology that “…it is generally accepted that the ideal muscle relaxant should have specificity and rapid onset of action, readily controllable intensity, wide margin between muscular relaxation and respiratory arrest and rapid and complete recovery after cessation of its administration.” They go on to state “…a recently introduced synthetic muscle relaxant, succinylcholine, . . . administered in the form of continuous intravenous infusion, approximated most closely the definition of the ideal muscle relaxant.” As with any new pharmacologic agent, further evaluation of its properties began. Many aspects were studied, including the physiologic effects caused by the administration of succinylcholine.

In 1953, it was reported that succinylcholine increased IOP. Numerous subsequent publications have explored the responsible mechanism and methods to attenuate this response. This intense interest was engendered by two articles that reported vitreous extrusion in surgical patients after administration of succinylcholine. However, these are not actual case reports. Rather, they are studies of intraocular physiology and IOP that include anecdotal personal communications from surgical colleagues to provide a rationale for the investigations. Lincoff et al. state that “…since the publication of the previous article [describing the effects of succinylcholine on IOP], various communications have been received from ophthalmologists who have used succinylcholine at surgery. These included several reports of cases in which succinylcholine was given to forestall impending vitreous prolapse, only to have a prompt expulsion of vitreous occur.” Four instances of personal communications are then given, with no other details provided. Presumably, succinylcholine was administered to patients who were already anesthetized. In the second article, Dillon et al. (fig. 1) stated that “…it has been reported to us by Godman that a small amount of vitreous was lost from the eye of a patient undergoing cataract surgery wherein succinylcholine was administered to the patient under light anesthesia at the time that the sclera had been incised and the anterior chamber opened.” Once again, reference four is a personal communication to the authors. They go on to conclude that “…it would appear, therefore, that the administration of succinylcholine for intraocular surgery is at least hazardous and possibly contraindicated [emphasis added]… It is highly probable that the use of succinylcholine in any form of ocular surgery is unwise since as Lincoff has pointed out, the eye tends to rotate away
Evolution of Thought

Reference books began incorporating the clinical recommendation of Dillon et al. One contemporary text stated that "...suxamethonium has been shown to cause contracture of the extraocular muscles and increase intraocular tension and it may well be that a nondepolarizing relaxant is the one of choice in intraocular operations [with reference to Dillon’s article]." The same text, in the next edition, is even more definitive, stating that "...[succinylcholine] should not be used for the first time during an operation when the eye is already open, for fear of precipitating vitreous prolapse." A similar example of this progression of thought is found in another major reference text of the time. In the second edition of Evans and Gray’s General Anaestesia, published in 1965, there is no mention of suxamethonium and risk of vitreous prolapse. However, the next edition, published in 1971, states that "...in the situation in which the cornea has been incised, coughing, retching, vomiting, and squeezing may be catastrophic, and the use of suxamethonium is strongly contra-indicated." By the time of the publication of Miller’s Anesthesia, first edition, in 1981, the authors stated clearly the prevailing belief that "...succinylcholine should be avoided in patients with open ophthalmic injuries." In the second edition, published in 1986, the authors reiterate that "...in penetrating injuries of the eye, the use of succinylcholine alone without controlling muscle fasciculations is contraindicated because succinylcholine causes a mean IOP increase of 7 mmHg..." They further state that "...one early case report by Dillon involved loss of vitreous during cataract surgery under light anesthesia, leaving the erroneous impression that this article was a case report rather than an investigation of intraocular physiology that included mention of an anecdotal incident. The text General Anaesthesia, which had stated that succinylcholine was "strongly contra-indicated" in the third edition (1971), somewhat softened this recommendation by the time of the fifth edition (1989) to state that "...suxamethonium is associated with a rise in IOP and thus there is the possibility that some of the contents of the perforated globe will be extruded." After mentioning the results of a study by Libonati et al. in which there was no loss of vitreous, the authors nonetheless go on to advocate a method for the “experienced” anesthetist using a nondepolarizing neuromuscular blocker with a priming dose and a larger induction dose of hypnotic agent. Thus, it is apparent that this recommendation in these texts was based on physiologic studies demonstrating clearly that succinylcholine can cause a small increase in IOP and the perception that there were well-documented cases of injury in the literature.

However, other opinions began to be expressed, based on actual case series and experimental reports. In 1986, Libonati et al. reported no extrusion of vitreous when using succinylcholine during induction for 73 cases of penetrating eye injuries. With this number of cases, the upper 95% CI for the frequency of extrusion is approximately 4%. They also state that they have had no anecdotal reports of loss of ocular content using succinylcholine for eye injury patients in more than 10 yr at the Wills Eye Hospital in Philadelphia, Pennsylvania. This study prompted much discussion, and letters to the editors revealed yet another anecdotal report, as follows: "The expulsion of intraocular content after succinylcholine induction is more than merely a theoretical concern. One of us (A.L.R.) has witnessed this complication, and the result was enucleation following a simple scleral..."
Another letter prompted by Libonati’s article briefly describes the long-term experience at the Massachusetts Eye and Ear Infirmary in Boston, Massachusetts, of more than 10 yr of inducing open globe injuries with succinylcholine without vitreous expulsion. Subsequently, Moreno et al. administered succinylcholine to a feline model of ocular trauma without extrusion of ocular contents.

**Current Thought**

Currently, anesthesia textbooks in general provide a fairly balanced view of the issue, with many authors advocating the careful use of succinylcholine in cases in which the prompt securing of the airway is indicated. For example, the most recent edition (published in 2000) of Miller’s *Anesthesia* no longer invokes the anecdotal report of Dillon et al. and presents a concise review of the relevant literature, both regarding the extent case series and the effects of succinylcholine and other peripherative factors on IOP. However, several other sources still stress the dangers of succinylcholine. In general, the authors of ophthalmology texts still regard succinylcholine as contraindicated in patients with open eye injuries. For example, a recent text states that “...sucinylcholine should be avoided [for significant ocular trauma] because it may cause initial cocontraction of the extraocular muscles and loss of intraocular contents.” The anesthesia journal literature still frequently invokes the reported extrusion of intraocular contents as a rationale for further clinical studies of anesthetic effects on IOP. A popular anesthesiology review used to educate residents also states that succinylcholine causes the extrusion of intraocular contents.

Thus, over a period of 45 yr, attitudes toward the role of succinylcholine in the management of patients with open eye injuries have evolved. There is room for legitimate differences of opinion regarding this issue. However, one striking feature of the story is the reliance on anecdote, rather than documented case reports, to define the clinical problem. At least up to the time of this review, there are still no well-documented case reports describing the extrusion of vitreous after succinylcholine was administered in an open globe surgery. One can argue whether anecdotes, which do not undergo peer review, should have a place in defining risk or determining practice.

The American Society of Anesthesiologists Closed Claims Project was designed in part to overcome underreporting and detect patterns of anesthetic injury. We queried this database to search for vitreous extrusion related to use of succinylcholine for repair of open globe injury of the eye. There were no claims for vitreous extrusion or blindness possibly related to succinylcholine among these claims (personal communication from Karen L. Posner, Ph.D., Project Manager and Health Systems Analyst for the ASA Closed Claims Project, Department of Anesthesiology, University of Washington, Seattle, Washington, January 11, 2002). It should be noted that the ascertainment of cases by the Closed Claims Project database is incomplete, and there is no way to know how many patients with ocular injury received succinylcholine over the period covered by the database. However, the significance of a lack of reported cases is strengthened by an argument based on biologic plausibility. When an open globe injury has occurred, it is often associated with crying, Valsalva maneuvers, forceful blinking, and rubbing of the eyes, all of which create a much larger rise in IOP than that associated with the use of succinylcholine. Thus, the increases in IOP produced by succinylcholine may be tempered by induction agents in the setting of rapid sequence induction for the repair of acute injuries and may prevent more devastating eye injury by profoundly paralyzing the muscles of the chest and bone coughing.

We can only speculate as to why the belief that succinylcholine is contraindicated in open eye injuries is seemingly so persistent, even when major anesthesia texts now suggest otherwise. Advocates of evidence-based practice would argue that, like other physicians, some anesthesiologists have an inadequate understanding of the current relevant literature. Conversely, our desire for “zero tolerance” of anesthesia-related morbidity may make us inherently very conservative. Even if we acknowledge that extrusion of vitreous has never been documented in a case report, it might have happened, and it might happen again. To follow the dictum “primum non nocere,” we thus avoid succinylcholine.

**Conclusions**

We have traced the origins of a common teaching in our specialty. It is likely that all anesthesia providers have been taught at one time or another that the use of succinylcholine in an open globe injury has caused the extrusion of ocular contents and should therefore be avoided.

The story of the evolution of thought regarding this issue illustrates the difficulties inherent in formulating practice recommendations to prevent rare anesthetic morbidity. Although it would be unwise to completely disregard the existing anecdotal reports, the lack of detailed data regarding the specific circumstances surrounding these events must serve to call into question a specific cause-and-effect relationship between vitreous extrusion and the drug itself. To base firm and often repeated clinical recommendations on such anecdotes also seems unwise.

**References**


