

## CASE REPORT

# Penile intracavernosal injection of succinylcholine for laryngospasm management during hypospadias repair

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### Abstract

**Background:** Laryngospasm is a serious anesthetic complication that can lead to acute airway obstruction and hypoxemia. Standard management involves deepening anesthesia and administering succinylcholine intravenously (IV) or intramuscularly (IM). However, if IV access is lost or IM drug delivery is too slow, alternative routes are required. We report the first known use of intracavernosal succinylcholine as a rescue intervention for refractory laryngospasm during pediatric hypospadias surgery.

**Case Presentation:** A 13-year-old obese male undergoing distal hypospadias repair developed persistent laryngospasm with desaturation. Initial IV propofol failed due to a dislodged IV line and IM succinylcholine (4 mg/kg) showed a delayed effect. Consequently, 0.5 mg/kg of succinylcholine was injected directly into the corpus cavernosum to utilize its rich vascular network for rapid absorption. Intracavernosal administration led to near-immediate relaxation, allowing effective ventilation and oxygenation recovery. The patient was intubated and surgery proceeded uneventfully. No complications occurred at the injection site or systemically, and the patient was discharged without sequelae.

**Conclusion:** This case demonstrates intracavernosal succinylcholine as a feasible emergency route when IV access is lost and IM delivery is insufficient. The corpora cavernosa's vascularity enabled rapid drug uptake similar to IV administration. This novel intervention highlights an interdisciplinary approach to airway emergencies and may be considered in extreme scenarios where standard methods fail. Nonetheless, it must be acknowledged that prior IM administration may have contributed to the clinical response, and further investigation is needed to establish the efficacy and safety of this route.

### KEYWORDS

airway management, emergency intervention, hypospadias, intracavernosal injection, laryngospasm, pediatric anesthesia, succinylcholine

## 1 | INTRODUCTION

Hypospadias is a common congenital anomaly among newborn males, often necessitating surgical intervention due to complications related to urination, penile curvature, and fertility concerns<sup>[1]</sup>. Various surgical approaches are currently employed for hypospadias repair, selected based on both the patient's condition and the surgeon's discretion. However, these surgeries uniformly entail the use of general anesthesia.

Anesthesia-induced laryngospasm has a higher prevalence in pediatric patients (3.3/1000), which further increases in younger ages<sup>[2]</sup>. The standard protocol for management of laryngospasm includes deepening anesthesia with additional intravenous (IV) propofol and/or employing succinylcholine to induce laryngeal muscle paralysis. In cases where IV access is not readily available, intramuscular (IM) succinylcholine may be administered, although this delivery method has a slower onset compared to IV administration. Typically, these interventions can resolve laryngospasm within 1 min. Although used less often, intralingual (IL) administration of succinylcholine leads to full paralysis and relaxation in a shorter period than IM, but it requires removal of the airway mask. Submental IL succinylcholine administration produces similar results to IM<sup>[3]</sup>. This effectiveness is due to the deep vascularization of the tongue, which facilitates rapid uptake of succinylcholine into the bloodstream.

This report describes a case of anesthesia-induced laryngospasm in an obese 13-year-old adolescent male who, despite the initial administration of IM succinylcholine, continued to desaturate. Notably, the innovative intervention of intracavernosal succinylcholine administration led to rapid resolution of the laryngospasm. This case report is the first documentation of such an intervention and suggests that intracavernosal administration may be a safe and feasible approach for succinylcholine administration in patients with laryngospasm.

## 2 | CASE PRESENTATION

A 13-year-old obese male (body mass index [BMI] of 30 kg/m<sup>2</sup>) with no significant past medical history was scheduled for distal penile hypospadias repair under general anesthesia. Following the induction of general anesthesia and the placement of a laryngeal mask airway, the patient was still reactive and experienced laryngospasm at the outset of the surgical procedure. Evidenced by high airway resistance, the inability to ventilate, and rapidly dropping oxygen saturation.

Immediate steps were taken to deepen anesthesia but the attempt to administer IV propofol failed because the IV catheter had become dislodged. Differential diagnoses for the acute airway obstruction (such as a

mechanical airway blockage or bronchospasm) were considered, but the clinical scenario strongly indicated laryngospasm triggered by airway stimulation. Subsequently, an intramuscular dose of succinylcholine (4 mg/kg) was administered into the left deltoid muscle to break the spasm. Despite this intervention, while waiting for the effect of IM succinylcholine, the patient's oxygen saturation continued to fall into the 60% range. At this point, the team was faced with a patient who could not be ventilated or intubated, and an urgent solution was needed.

Recognizing the critical nature of the situation, the urologic surgeon proposed an alternative approach, suggesting the intracavernosal administration of succinylcholine to expedite absorption into the bloodstream, thereby achieving a more rapid onset of action. Following the preparation of the surgical site with betadine and draping of the penis, 0.5 mg/kg of succinylcholine was administered directly into the penile corpora at the 9 o'clock position. The rationale was that the penile corpora's rich vascularity could provide accelerated systemic absorption of the drug, akin to an IV injection. Within seconds of the intracavernosal administration, the patient's laryngospasm abated, allowing manual ventilation to resume with improving chest rise. Oxygenation showed immediate improvement as the saturation rose. The laryngospasm was broken and much more quickly than would be expected from the ongoing IM dose alone.

Following the resolution of the spasm, the airway was secured with an endotracheal tube for the remainder of the procedure, given the airway reactivity encountered. The planned surgery then proceeded without further incident as the patient's vital signs stabilized with peripheral oxygen saturation (SpO<sub>2</sub>) returning to normal range. By the end of the hypospadias repair, the patient had fully recovered from anesthesia and the neuromuscular blockade. He was successfully extubated in the operating room without any recurrence of laryngospasm. Postoperatively, the patient was monitored and found to have no local complications at the injection site (such as bleeding, hematoma, or penile tissue injury) and no systemic side effects (such as arrhythmia or prolonged paralysis). He was discharged home the same day with no adverse outcomes noted. This outcome suggests that the intracavernosal succinylcholine provided the necessary rapid muscle relaxation in a life-threatening scenario, with an excellent recovery and no apparent sequelae.

## 3 | DISCUSSION

Laryngospasm during anesthesia induction is a critical event necessitating rapid and effective intervention to prevent respiratory decline. The standard treatment consists of IV propofol to further deepen the anesthesia

and IM succinylcholine, administered if IV access is unavailable<sup>[4]</sup>. Succinylcholine, as a depolarizing neuromuscular blocking agent, binds to nicotinic acetylcholine receptors in the motor end plates of skeletal muscles, leading to membrane depolarization and the generation of action potentials. This process results in the release of calcium from the sarcoplasmic reticulum (SR), initiating muscle contraction, which is followed by muscle relaxation when calcium is pumped back into the SR. As a result, succinylcholine first induces muscle fasciculations followed by flaccid muscle paralysis within 60 s of administration<sup>[5]</sup>. In this case, the standard approach was impeded by the loss of IV access and the patient's body habitus. An IM injection of succinylcholine was performed successfully; however, the patient continued to experience respiratory decline during the onset of action which prompted further intervention. In our patient, the time-critical nature of the laryngospasm meant that waiting for the IM dose to take full effect risked prolonged hypoxia. This necessitated exploration of an alternative delivery route for succinylcholine to achieve paralysis as quickly as possible.

The urologic surgeon's proposal for intracavernosal succinylcholine administration is rooted in the extensive vascularization of the penis. The penis is primarily perfused by the internal pudendal artery, which arises from the internal iliac artery. The external pudendal artery, originating from the femoral artery, provides supplementary blood flow to the proximal shaft skin and superficial structures. On the other hand, the deep dorsal veins, cavernosal veins, and para-arterial veins provide venous drainage through different pathways. This extensive venous drainage system, together with the arterial supply, provides a rapid conduit from the corpora cavernosa to central circulation, facilitating swift systemic absorption of locally injected agents.

Intracavernosal injections have been a prevalent practice for diagnosing and treating erectile dysfunction (ED) since the 1980s following the introduction of intracavernosal papaverine injections. Due to its limited efficacy as a monotherapy, it has been combined with phentolamine mesylate to produce Bimix and subsequently with phentolamine mesylate and alprostadil to produce Trimix, both of which are regularly used in ED management. These combination drugs have significantly increased efficacy and decreased side effects, but penile pain, corporal fibrosis, and priapism remain as possible side effects<sup>[5,6]</sup>. Intracavernosal epinephrine injections have also been employed to treat priapism<sup>[7]</sup>. Following intracavernosal phenylephrine for the management of priapism, vitals must be carefully monitored as systemic absorption of the medication can lead to cardiovascular events such as reflex bradycardia and hypertension<sup>[8]</sup>. Given the minimal amount of musculature in the body of the penis, there is a low risk for local side effects following intracavernosal administration of succinylcholine.

Systemic absorption of intracavernosal medications has been well-documented in previous medical literature, with pharmacokinetic studies demonstrating measurable peripheral blood levels of tested agents. For example, sensitive gas chromatography/mass spectrometry has demonstrated measurable peripheral plasma concentrations and metabolite levels following intracavernosal injection of alprostadil<sup>[9]</sup>. Alprostadil undergoes rapid metabolism, showing increased peripheral levels of its primary metabolite at 30 min and then returning to baseline by 60 min<sup>[10]</sup>. On the other hand, papaverine drains slowly into systemic circulation showing slightly elevated peripheral levels at 30 and 60 min after injection<sup>[9]</sup>. It is important to note that the resistance of the cavernous wall influences how the drug is absorbed and patients with cavernous leakage can demonstrate significantly higher levels of absorption into systemic circulation<sup>[11]</sup>. Collectively, this research supports the physiological plausibility of using the intracavernosal route for rapid systemic drug delivery, highlighting the potential applicability of the corpora for rapid systemic absorption of medications such as succinylcholine used in this case.

This case demonstrates that the penile intracavernosal injection effectively functioned as a rapid delivery route for succinylcholine, producing the desired muscle relaxation in a fraction of the time that the IM route was taking. The improvement in oxygenation and ability to ventilate occurred almost immediately after the injection, indicating that the succinylcholine entered the bloodstream and reached the laryngeal musculature quickly. In an obese patient with a potentially prolonged IM drug uptake, this approach circumvented the delay and prevented further hypoxic deterioration<sup>[12]</sup>. The patient's safe outcome, with successful completion of surgery and no complications, suggests that, in dire situations, an intracavernosal injection can serve as a practical surrogate for IV access when the latter is compromised. We acknowledge that this is an unusual application of a technique from one specialty (urology) to solve a critical problem in another (anesthesiology/airway management). To our knowledge, no prior reports have described using the intracavernosal route to administer a neuromuscular blocker for laryngospasm, making this a novel contribution to the literature on airway emergency management. It illustrates how cross-disciplinary thinking can yield life-saving solutions.

While the success in this single case is encouraging, it is important to consider that further evidence is needed before this technique can be widely recommended. Several important limitations must be acknowledged. First, this case report represents a single case, and the patient had received IM succinylcholine approximately 1–2 min prior to the intracavernosal injection. Although the timeline of events suggests that the intracavernosal route produced rapid relaxation, it is

possible that the observed resolution of the laryngospasm resulted, at least in part, from the effect of the IM dose. Furthermore, the safety profile of intracavernosal succinylcholine (i.e., risks of tissue injury, priapism, or cardiovascular effects from rapid systemic absorption) remains unknown. Additionally, generalizability is limited by patient-specific factors including age, body habitus, and the specific clinical factors (i.e., dislodged IV access). Prospective studies with appropriate controls would be necessary to properly establish the efficacy and safety of intracavernosal succinylcholine as an emergency airway management technique. Nonetheless, this case opens the door for discussion and investigation into alternative drug delivery routes in emergency situations. In particular, anesthesiologists and surgeons working with pediatric patients or other difficult scenarios might consider the corporal injection route as an option of last resort when conventional methods to break laryngospasm are failing and the patient's life is at risk.

## 4 | CONCLUSION

Intracavernosal succinylcholine injection can be a viable rescue technique for resolving acute laryngospasm when standard IV access is lost and IM administration is too slow. This case highlights the extreme scenario in which a rapid, creative intervention prevented a potential catastrophe. The rich vascularity of the penile corpora allowed succinylcholine to reach the circulation quickly, mimicking an IV bolus and achieving paralysis of the laryngeal muscles in time to avert critical hypoxia. Adapting a well-known urological injection route to an airway emergency underscores the importance of interdisciplinary collaboration and innovation in patient care. While this is the first reported instance of such an approach, and routine use is not suggested without further study, it provides a proof of concept that could inform future management of anesthesia-related laryngospasm or similar crises. Ultimately, our experience suggests that in desperate situations, considering unconventional drug delivery routes—grounded in sound anatomical and physiological rationale—may save lives. We recommend that anesthesiology and surgical teams be aware of this potential intervention and that further research or case reports be conducted to better establish its safety and efficacy. The lesson from this case is that maintaining oxygenation is paramount, and every second counts during laryngospasm; having an alternative means to rapidly deliver lifesaving medication can make the difference in patient outcomes.

## AUTHOR CONTRIBUTIONS

Diego R. Álvarez Vega was responsible for conceptualization, data curation, investigation, formal analysis, visualization, writing the original draft, and review and

editing; he initiated and led the writing process, conducted the literature review, coordinated the team's feedback, and proofread, edited, and structured the paper for final submission. Mariela R. Martinez contributed to investigation, conceptualization, data curation, visualization, and writing (review and editing), having witnessed the events firsthand, she played a crucial role in obtaining detailed clinical information from the treating team. Steven Friedman was involved in conceptualization, methodology, investigation, data curation, and writing (review and editing); he conceived the novel intervention of injecting succinylcholine into the corpus cavernosum, and clarified clinical details. Tehilla Adams contributed to conceptualization, methodology, and writing (review and editing), serving as the anesthesiologist and supplying critical information regarding intervention dosing. William Nguyen and Jordan L. Mendelson were responsible for validation and writing (review and editing), assisting in the refinement and editing of the final draft. Jordan S. Gitlin contributed to conceptualization, data curation, formal analysis, investigation, methodology, resources, supervision, and writing (review and editing); he collaborated with Steven Friedman during the case, gathered essential anatomical and literature data, facilitated team communication, and provided ongoing supervision throughout the project.

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## CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new datasets were generated or analyzed during the current study. All relevant clinical details are included within the manuscript.

## ETHICS STATEMENT

Informed consent for the publication of the case details was obtained from the patient's legal guardians. Additionally, verbal assent was obtained from the patient. All data have been de-identified to protect patient privacy and no identifiable patient information was used.

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