

Inadvertent Intra-Arterial Administration of Rocuronium During Anesthetic Care in a Sixteen-Year-Old Patient

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Abstract

The inadvertent intra-arterial (IA) injection of medications can result in significant clinical sequelae, including paresthesia, pain, loss of motor function, compartment syndrome, gangrene, and loss of digits or limb. We present the inadvertent IA administration of rocuronium during intraoperative anesthetic care of a 16-year-old patient. Following the inhalation of incremental concentrations of sevoflurane in nitrous oxide and oxygen, an intravenous (IV) cannula was placed in the left antecubital fossa. Rocuronium was administered through an IV cannula to facilitate endotracheal intubation. The forearm and hand became mottled and it was determined that the cannula was in the brachial artery. During the ensuing 2 h, there was a gradual return of the extremity to its baseline appearance. The patient was discharged home and no further sequelae were noted. Previous reports of the IA injection of neuromuscular blocking agents are reviewed, techniques to prevent such problems discussed, and a pathway for treatment outlined.

Keywords: Rocuronium; Intra-arterial injection; Vascular injury; Gangrene; Compartment syndrome

Introduction

During intraoperative surgical care, the intravenous (IV) injection of medications including neuromuscular blocking agents (NMBAs) as well as sedative/analgesic agents is routinely carried out to induce and maintain general anesthesia. The inadvertent intra-arterial (IA) injection of medications may be a source of significant morbidity, potentially leading to clinically significant sequelae including paresthesia, pain, motor dys-

function, compartment syndrome, gangrene, and loss of digits or limb [1, 2]. We present the inadvertent IA administration of rocuronium to a 16-year-old patient during anesthetic care. Previous reports of the IA administration of commonly used NMBAs are reviewed, techniques to prevent such problems discussed, and a pathway for treatment outlined.

Case Report

Investigations

Review of this case and presentation in this format followed the guidelines of the Institutional Review Board of Nationwide Children's Hospital. This review was conducted in compliance with the ethical standards of the responsible institution on human subjects as well as with the Helsinki Declaration.

A 52.1 kg, 16-year-old male with non-verbal autism presented for magnetic resonance imaging. The patient's previous history included congenital rubella syndrome and congenital heart disease with previous surgical intervention. The patient was held *nil per os* for 8 h and transported to the operating room where routine American Society of Anesthesiologists' monitors were placed. Following the inhalation of incremental concentrations of sevoflurane in nitrous oxide and oxygen, an IV cannula was placed in the left antecubital fossa. Although the IV infusion did not flow by gravity, it flushed easily. Rocuronium (50 mg) was administered through the IV to facilitate endotracheal intubation. Onset of neuromuscular blockade was noted within 60 s and the trachea was intubated without difficulty.

Diagnosis

After the administration of rocuronium, it was observed that the IV did not flow by gravity and pulsatile blood was returning into the IV tubing. Physical examination demonstrated mottling of the forearm and hand.

Treatment

An alternative peripheral IV was placed in the right arm and the left catheter, which was assumed to be in the brachial artery, was removed. The imaging procedure was completed without

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Table 1. Case Reports of Intra-Arterial Administration of Neuromuscular Blocking Agents

Author	Patient demographics and surgical procedure	Clinical course and outcome
Nicolson et al [3]	An 8-day-old, 2.7 kg neonate with hypoplastic left heart syndrome presenting for stage I palliation	Intentional IA administration of pancuronium (0.15 mg/kg) and fentanyl through a radial artery prior to cardiac surgery.
Joshi and Tobias [4]	A 10-month-old, 7.6 kg infant and a 12-month-old, 8.2 kg infant presenting for Blalock-Taussig shunt	Intentional IA administration of 1 or 1.5 mg vecuronium in femoral artery. No long-term sequelae.
Rao [5]	A 59-year-old, 101 kg man for emergent coronary revascularization	Intentional IA administration of rocuronium (60 mg) via the radial artery. No long-term sequelae.
Shukla et al [6]	An 8-year-old, 45 kg girl for ORIF of the clavicle	Inadvertent IA administration of rocuronium (50 mg) through a catheter in the antecubital fossa. Inadvertent IA placement due to patient's high BMI and uncooperative state. No long-term sequelae.
Kessell and Barker [7]	An 11-month-old, 10.4 kg toddler for tonsillectomy	Inadvertent IA administration of succinylcholine (20 mg) and atracurium (3 mg) via the femoral artery. Transient blanching and ischemic changes of leg. No long-term sequelae.
Gorman and Dearlove [8]	A 30-month-old, 8.3 kg toddler for reduction of congenital hip dislocation	Inadvertent IA administration of atracurium (0.5 mg/kg) via the brachial artery. No long-term sequelae.
Devlin and Bali [9]	A 28-year-old man for tonsillectomy	Inadvertent IA administration of tubocurarine (4 mg) in the antecubital fossa. No long-term sequelae.

BMI: body mass index; IA: intra-arterial; ORIF: open reduction, internal fixation.

incident and the patient was transported to the post-anesthesia care unit (PACU). Ongoing examination of the left hand and arm demonstrated intact pulses and improving capillary refill over the ensuing 30 min.

Follow-up and outcome

Examination postoperatively in the PACU revealed that the hand and arm had returned to their normal preoperative appearance. The patient's mother was informed of the event and a full discussion ensued regarding indications for follow-up after discharge. The patient was observed postoperatively for 2 h in the PACU and no additional changes were noted in the left extremity. The patient was discharged home. A follow-up phone call the next day revealed that the patient continued to do well with no sequelae from the IA injection.

Discussion

We present the outcomes following the inadvertent IA administration of rocuronium in a 16-year-old patient. Although the onset of neuromuscular blockade was rapid, after administration, the IV did not flow by gravity and pulsatile blood returned into the tubing. Physical examination demonstrated mottling of the forearm and hand. An alternative peripheral IV was placed in the right arm and the left catheter was removed. Ongoing examination of the left hand and arm during the procedure demonstrated intact pulses and improving capillary refill over the ensuing 30 min. Over the next 2 h, there was resolution of the changes and the patient was discharged home with no further sequelae noted.

The IA administration of medications may be a deliberate choice when vascular access is problematic or may occur as

the result of inadvertent administration through a cannula that is thought to be venous, but is in fact arterial (Table 1) [3-9]. The first reports of the IA administration of NMBAs described the intentional use of the IA route in a cohort of pediatric patients with congenital heart disease. Nicolson et al reported the administration of pancuronium and fentanyl through the radial artery of an 8-day-old, 2.7 kg neonate with hypoplastic left heart syndrome presenting for surgical palliation [3]. When IV access could not be readily obtained, pancuronium (0.15 mg/kg) and fentanyl (20 µg/kg) were administered through an indwelling radial artery catheter. This was followed by the subsequent IA administration of pancuronium to a cohort of 50 pediatric patients. In these patients, IA administration was used when IV access could not be rapidly achieved to avoid the prolonged administration of an inhaled anesthetic agent, halothane, by mask and its potential hemodynamic effects. The IA administration of pancuronium resulted in a rapid onset of neuromuscular blockade allowing for endotracheal intubation without clinical sequelae of the involved extremity.

Similar efficacy and safety was reported by Joshi et al in two patients with severe cyanotic congenital heart disease who presented for surgical palliation (Blalock-Taussig shunt placement) [4]. When IV access could not be rapidly obtained following the inhalational induction of anesthesia with sevoflurane, vecuronium was administered through a femoral artery catheter to facilitate endotracheal intubation. This was followed by placement of a central venous catheter in the internal jugular vein. Of note, this report also shared personal experience with the IA administration of cis-atracurium that resulted in temporary regional circulatory compromise with transient vasospasm of the involved extremity potentially related to the low pH of the solution, leading the authors to caution against its IA administration.

Additional anecdotal reports have also outlined the inadvertent administration of NMBAs including rocuronium, suc-

cynylcholine, atracurium, and curare. Shukla et al reported the inadvertent IA administration of rocuronium in an 8-year-old patient presenting for open reduction, internal fixation of a clavicle fracture through a cannula placed within the antecubital fossa [6]. The events of this case and the outcome are similar to those noted in our patient. However, their patient developed severe hyperemia and delayed capillary refill which resulted in the decision to administer IA heparinized saline and lidocaine. Other authors reported the inadvertent IA administration of succinylcholine and atracurium via the femoral artery in an 11-month-old toddler that resulted in cutaneous flushing and a transient ischemic appearance of the extremity [7]. A caudal injection of 10 mL of 0.25% bupivacaine was administered to provide sympathectomy, vasodilation, and improved regional blood flow. The caudal block resulted in the return of strong peripheral pulses in the lower extremity.

To date, the majority of information regarding the safety of the IA administration of NMBAs is from anecdotal experience, much of it related to inadvertent administration. Consequences of IA may be the result of the medication itself or the diluent. Joshi et al outlined the constituents and pH of the more commonly used NMBAs in an attempt to determine their safety for IA administration [4]. Benzyl alcohol, which may be used as a preservative and bacteriostatic agent for diluting or dissolving medications for IV administration, may initiate vasospasm and IA injection-related tissue damage. Therefore, when medications (i.e., vecuronium) need to be diluted or reconstituted for IA administration, non-bacteriostatic saline should be used as the diluent. Another consideration which may impact the safety of the IA route is the site of the arterial catheter. Catheters in high flow areas may provide safer conditions of IA administration. When positioned in the femoral or umbilical artery, the catheters are in an area of higher flow than radial arterial catheters which may result in greater dilution of the medication and less impact of distal flow.

Various factors may contribute to inadvertent IA cannulation. These factors include anatomical proximity at the cannulation site of the vein and artery, aberrant vasculature, high BMI, and excessive patient movement. High risk anatomical insertion sites such as the antecubital fossa and femoral vessels increase the chances of inadvertent IA cannulation due to proximity of vessels. The median distance in adults between the median cubital vein and the brachial artery is 3.6 mm [10]. The femoral vein catheter insertion point is 1 cm medial to the femoral artery [6]. Aberrant radial artery trajectories can contribute to the incidence of inadvertent arterial cannulation [2]. Other conditions which may increase procedural difficulty such as an uncooperative patient or a high BMI may make accurate IV cannulation more difficult to achieve, increasing the likelihood of IA cannulation [6]. However, the advent of ultrasound-guided vascular access may mitigate these concerns.

Identification of the inadvertent placement of a catheter in an artery is key in avoiding inadvertent IA injection injury. Venous cannulation results in access that flows freely by gravity. In our patient, the medication was injected following vascular cannulation without confirmation of gravity flow. With arterial cannulation, there may be backflow of bright red blood into the IV tubing which is often identified as pulsatile. In addition to

identification prior to medication administration, early identification of IA cannulation may be possible following drug administration. If IA cannulation is suspected, blood gas analysis or pressure transduction can confirm the location [1].

In summary, we present the inadvertent IA administration of rocuronium during anesthetic care in a 16-year-old patient. Although initial cutaneous changes were noted in the hand and arm, these resolved over the ensuing 2 h. When inadvertent IA administration of any medication occurs, the primary concern centers around its impact on distal perfusion and blood flow. The main objectives of treatment are symptomatic relief and maintenance of adequate perfusion distal to the injection site. Suggested adjunctive pharmacological therapies include anticoagulation, local anesthetic agents, vasodilatory agents, platelet inhibitors, corticosteroids, and various other pharmacological agents [11]. When pharmacological therapy is considered, the catheter may be left IA to facilitate the direct local administration of the medication to promote adequate perfusion and treatment of vasospasm. The maintenance of cannulation also allows for direct access for angiography if needed to evaluate perfusion status [1]. When pharmacological intervention fails and there is progressive tissue damage, vascular surgery and interventional radiology consultation is recommended.

Learning points

The incidence of inadvertent IA injection of medication has been reported in the range of 1 in 3,440 to 1 in 56,000 [2]. Anecdotal reports have outlined the consequences of the intentional and inadvertent administration of various NMBAs including rocuronium, pancuronium, vecuronium, atracurium, cis-atracurium, curare, and succinylcholine. Transient local circulatory changes have been noted with rocuronium, atracurium, cis-atracurium, and succinylcholine. Successful use of both pancuronium and vecuronium has been reported when intravascular access is delayed. The onset times of these NMBAs parallel that with IV administration. Although offered as an option when IV cannulation is delayed, with the increased expertise with ultrasound-guided vascular access or intra-osseous administration, the intentional use of the IA route may be limited.

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Financial Disclosure

None to declare.

Conflict of Interest

None to declare.

Informed Consent

Informed consent was obtained for hospital/anesthetic care and the use of de-identified information for publication.

Author Contributions

CR: preparation of initial, subsequent, and final drafts; SH: direct patient care, literature review, review of drafts and final document; AS: literature review, review of drafts and final document; JDT: concept, writing, and review of all drafts.

Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author.

References

1. Sen S, Chini EN, Brown MJ. Complications after unintentional intra-arterial injection of drugs: risks, outcomes, and management strategies. *Mayo Clin Proc.* 2005;80(6):783-795. [doi pubmed](#)
2. Lokoff A, Maynes JT. The incidence, significance, and management of accidental intra-arterial injection: a narrative review. *Can J Anaesth.* 2019;66(5):576-592. [doi pubmed](#)
3. Nicolson SC, Pasquariello CA, Campbell FW. Intra-arterial injection of pancuronium and fentanyl—an alternative. *Crit Care Med.* 1988;16(9):915. [doi pubmed](#)
4. Joshi G, Tobias JD. Intentional use of intra-arterial medications when venous access is not available. *Paediatr Anaesth.* 2007;17(12):1198-1202. [doi pubmed](#)
5. Rao SL. The use of a Laryngeal Mask Airway in cardiac anesthesia and intra-arterial injection of rocuronium. *J Clin Anesth.* 2008;20(2):158-159. [doi pubmed](#)
6. Shukla A, Bt Abdul Ghaffar Z, Joshi S. Inadvertent intra arterial injection of Rocuronium: A case report. *The Internet Journal of Anesthesiology.* 2008;19:1.
7. Kessell G, Barker I. Leg ischaemia in an infant following accidental intra-arterial administration of atracurium treated with caudal anaesthesia. *Anaesthesia.* 1996;51(12):1154-1156. [doi pubmed](#)
8. Gorman A, Dearlove OR. Intraarterial atracurium followed by difficult intubation in a child with congenital muscular dystrophy. *Paediatr Anaesth.* 1999;9(3):277. [doi pubmed](#)
9. Devlin E, Bali I. Accidental intra-arterial injection of tubocurarine. *Anaesthesia.* 1991;46(1):75-76. [doi pubmed](#)
10. Mukai K, Nakajima Y, Nakano T, Okuhira M, Kasashima A, Hayashi R, Yamashita M, et al. Safety of venipuncture sites at the cubital fossa as assessed by ultrasonography. *J Patient Saf.* 2020;16(1):98-105. [doi pubmed](#)
11. Devulapalli C, Han KD, Bello RJ, LaPorte DM, Hepper CT, Katz RD. Inadvertent intra-arterial drug injections in the upper extremity: systematic review. *J Hand Surg Am.* 2015;40(11):2262-2268.e2265. [doi pubmed](#)