Gadolinium Aspiration Following Inadvertent Endotracheal Tube Cuff Injection in a Pediatric Patient

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Abstract

Introduction Gadolinium-based contrast agents (GBCA) are frequently used for MRI contrast studies. We report a case of pulmonary aspiration secondary to inadvertent GBCA injection.

Case Report A 12-year-old female with a past medical history significant for mitochondrial disorder, bronchial asthma, autism, recurrent urinary tract infection, epilepsy, developmental delay, dysautonomia, and thrombocytopenia was scheduled for a contrast-enhanced MRI study using gadoterate meglumine for urinary incontinence. The patient was sedated and intubated in preparation for the study, during which 10 mL of gadoterate meglumine was inadvertently injected into the endotracheal tube cuff pilot line instead of intravenously. The patient remained intubated and was admitted to the intensive care unit with continuous monitoring for signs of pulmonary injury or gadolinium toxicity. She was successfully extubated approximately 24 hours later without complication.

Discussion A variety of adverse effects attributable to parenteral GBCA exposure have been reported ranging from mild irritation to life-threatening anaphylaxis. Gadolinium deposition and storage have been implicated in a number of those adverse effects and multiple treatments modalities have been suggested, but no scientifically guided management exists.

Conclusion This case of pulmonary aspiration secondary to inadvertent GBCA injection in a pediatric patient demonstrated no acute side effects or complications within the first 24 hours. With the wide range of adverse effects attributed to gadolinium use in the medical literature, it is difficult to predict potential future adverse effects.

Keywords Gadolinium · Aspiration · Contrast · Gadolinium deposition disease · Gadolinium-based contrast agents

Introduction

Gadolinium-based contrast agents (GBCA) are frequently used for MRI contrast studies. This material generally poses minimal risk to patients with the exception of chronic renal failure patients, who may be at risk for nephrogenic systemic fibrosis (NSF) [1]. An increasing number of adverse effects is being attributed to parental GBCA administration due to the retention and deposition in various tissues in patients with normal renal function. Adverse effects attributable to gadolinium exposure have included neurotoxicity and nephrotoxicity

[2]. We report a case of pulmonary aspiration secondary to inadvertent GBCA injection.

Case Report

A 12-year-old female with a past medical history significant for mitochondrial disorder, bronchial asthma, autism, recurrent urinary tract infection (UTI), epilepsy, developmental delay, dysautonomia, and thrombocytopenia was scheduled for a contrast-enhanced MRI study using Dotarem® (gadoterate meglumine) for urinary incontinence. Vital signs prior to the procedure were heart rate 104 bpm, blood pressure 123/75 mmHg, respiratory rate 24/minute, temperature 36.8 degrees C, pulse oximetry 100% on room air. The patient was sedated and intubated in preparation for the study, during which 10 mL of gadolinium meglumine was inadvertently injected into the line used to inflate the endotracheal tube cuff (the pilot line) (Fig. 1) instead of

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Fig. 1 Endotracheal tube similar to that used in the patient showing the endotracheal cuff inflation line (pilot line)

intravenously (Fig. 2). This caused the endotracheal tube cuff to rupture resulting in the contrast material being injected into the patient's respiratory tract.

During contrast injection, a decrease in end-tidal CO_2 with loss of plateau was noted on capnography, suggesting a cuff leak. There were no changes in oxygen saturation which remained at 100% and no other hemodynamic changes were observed. Tidal volumes were decreased on controlled ventilation, FiO_2 was increased to 100%, and a search for a circuit leak was conducted.

It was noticed that the contrast was not seen in the post-contrast portion of the exam and that the contrast injection tubing was found attached to the endotracheal tube cuff pilot line. Upon aspiration of the pilot line, 1–2 cm of fluid were recovered, and an attempt to re-inflate the balloon cuff failed denoting a rupture. Foam encountered in the oral cavity was suctioned, and the patient was re-intubated using a different endotracheal tube (ETT). Suction using a 14 Fr catheter through the ETT removed minimal secretions. Vital signs following the incident were heart rate 101 bpm, blood pressure

117/79 mmHg, respiratory rate 20/minute, temperature 36.6 degrees C, pulse oximetry 100% on FiO_2 40%.

Pulmonology service was consulted to evaluate the patient in the MR suite. A decision was made to transfer the patient to the intensive care unit for close monitoring, and medical toxicology was consulted at the time of patient transfer.

The incident was reported to the section chief and administrator of the radiology department, and a safety report was created for the risk management department.

Her repeat chest radiograph was normal, and she was successfully extubated approximately 24 hours later without complication. She was observed for an additional 24 hours and was discharged home without developing signs or symptoms of pulmonary injury or systemic symptoms of gadolinium toxicity.

Laboratory values before and after the incident and at 2 month follow up after the incident were within normal limits with the exception of bicarbonate which was mildly below normal range (prior to incident 21 mmol/L; after the incident 17 mmol/L; 2 months 19 mmol/L: normal range 20–28 mmol/L).

Serial follow-up appointments for post-exposure monitoring were performed at 2 and 7 months post-incident. At both appointments, the mother mentioned that the patient had complaints of acute upper respiratory infection with asthma exacerbation in the interim, but no complaints of skin changes or pain. Consent for publication of this case report was obtained from the caregiver and provided to the journal in accordance with JMT policy.

Discussion

GBCAs are aqueous solutions containing gadolinium used in magnetic resonance (MR) studies. Our patient received Dotarem® which is a sterile, clear, colorless to yellow, aqueous solution for intravenous injection containing 376.9 mg/mL of gadoterate meglumine with no added preservatives [3].

Fig. 2 Similarity between the injection port of the endotracheal tube cuff inflation line (arrow) and a standard Luer lock intravenous injection port (arrowhead)

Gadoterate meglumine is a paramagnetic macrocyclic ionic agent with a mean elimination half-life after intravenous administration of about 1.4 ± 0.2 hours and 2.0 ± 0.7 hours in female and male subjects, respectively. The degree of absorption from the pulmonary tract is unknown. Inadvertent endotracheal administration may be anticipated to result in local irritation and hence chemical pneumonitis [3].

A variety of adverse effects have been reported after intravenous administration of GBCA. These reports range from self-limited allergic or physiologic reactions to life-threatening anaphylaxis [2]. A more debilitating adverse event is nephrogenic systemic fibrosis (NSF) which typically occurs in patients with renal failure exposed to GBCA, resulting in systemic fibrosis affecting the skin, muscles, and internal organs. The exact mechanism by which this occurs has not yet been fully elucidated, but the incidence of NSF has decreased following a change in practice patterns involving screening patients for renal impairment and modifying the imaging procedures as appropriate. Gadolinium deposition disease (GDD) is a separate and distinct disease process that has recently been described. GDD is postulated to occur due to retained GBCAs in the body undergoing dechelation followed by gadolinium deposition in different tissues [2]. Reports of patients with normal renal function subsequently developing symptoms after parenteral exposure to GBCA have been published. These symptoms included central torso pain, paresthesia, clouded mentation, pain in the hands and feet, difficulty in breathing, headache, and skin changes [4]. Individual case reports of acute tubular necrosis, acute pancreatitis, and encephalopathy following the use of GBCA have also been described [2].

When injected intrathecally, GBCAs have been reported to cause confusion, nausea, vomiting, ataxia, nystagmus, hallucinations, blurred vision, and depressed mental status [5].

Serum, hair, or urine gadolinium concentrations may provide more insight on the absorption and distribution of gadolinium following respiratory exposure [6]. Optimal treatment of patients with gadolinium toxicity after intravenous administration of contrast is unclear. Agents including *N*-acetylcysteine, anti-inflammatories, heavy metal chelators, and nanoparticles linked to chelators have been proposed as treatment strategies, but evidence supporting them is limited [2, 6, 7].

In this case, no acute clinical pulmonary toxicity developed, and the patient had an unremarkable hospital course, but the potential future pulmonary adverse effects in this patient are difficult to predict. Reporting this event to the section chief and risk management according to our institutional protocol were important steps during the evaluation and treatment of this patient post-procedure.

Limitations of our case report include the duration of follow-up. At both post-exposure assessments, the patient's caregiver reported the patient had symptoms consistent with upper respiratory infections with asthma exacerbation. Although the reported asthma exacerbations were

similar in severity and duration to the patient's baseline condition prior to the incident, we cannot exclude the gadolinium exposure as a contributing factor to either the upper respiratory infections or the asthma exacerbations.

Conclusions

We report a case of pulmonary aspiration secondary to inadvertent GBCA injection. In this case, there was no evidence of acute pulmonary or systemic toxicity. However, with a wide range of organ toxicity reported after intravenous gadolinium exposure, it is unclear whether a similar degree of risk exists after accidental pulmonary exposure. Close long-term follow-up would be useful to detect any long-term pulmonary or systemic toxic effects.

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Compliance with Ethical Standards

Consent for publication of this case was obtained and provided to the journal in accordance with JMT policy.

Conflict of Interest None.

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