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Clinical Investigation: Pediatric

Repetitive Pediatric Anesthesia in a Non-Hospital Setting

Jeffrey C. Buchsbaum, MD, PhD, AM,*,† Kevin P. McMullen, MD,*,† James G. Douglas, MD, MS,*,† Jeffrey L. Jackson, MD,† R. Victor Simoneaux, RTT,† Matthew Hines, RTT,† Jennifer Bratton, RN,† John Kerstiens, CPA,† and Peter A.S. Johnstone, MD, FACR*,†

From the *Department of Radiation Oncology, Indiana University School of Medicine, Indianapolis, Indiana; and †Indiana University Health Proton Therapy Center, Bloomington, Indiana

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Summary

Proton radiation therapy is usually delivered away from comprehensive pediatric emergency services. Strict protocol adherence and a well-trained team contribute to safe daily sedation/anesthesia for proton therapy.

Purpose: Repetitive sedation/anesthesia (S/A) for children receiving fractionated radiation therapy requires induction and recovery daily for several weeks. In the vast majority of cases, this is accomplished in an academic center with direct access to pediatric faculty and facilities in case of an emergency. Proton radiation therapy centers are more frequently free-standing facilities at some distance from specialized pediatric care. This poses a potential dilemma in the case of children requiring anesthesia.

Methods and Materials: The records of the Indiana University Health Proton Therapy Center were reviewed for patients requiring anesthesia during proton beam therapy (PBT) between June 1, 2008, and April 12, 2012.

Results: A total of 138 children received daily anesthesia during this period. A median of 30 fractions (range, 1-49) was delivered over a median of 43 days (range, 1-74) for a total of 4045 sedation/anesthesia procedures. Three events (0.0074%) occurred, 1 fall from a gurney during anesthesia recovery and 2 aspiration events requiring emergency department evaluation. All 3 children did well. One aspiration patient needed admission to the hospital and mechanical ventilation support. The other patient returned the next day for treatment without issue. The patient who fell was not injured. No patient required cessation of therapy.

Conclusions: This is the largest reported series of repetitive pediatric anesthesia in radiation therapy, and the only available data from the proton environment. Strict adherence to rigorous protocols and a well-trained team can safely deliver daily sedation/anesthesia in free-standing proton centers.

Introduction

One of the logistical challenges in managing a radiation oncology service including pediatric and some adolescent/young adult patients is the requirement for daily sedation/anesthesia (S/A). The pediatric anesthesia team is required to function away from the relative safety provided by the operative suite with regard to staffing, equipment, and proximity to acute care facilities (1-5).

Reprints are not available. Please direct comments to Jeffrey C. Buchsbaum, MD, PhD, AM, Department of Radiation Oncology, Indiana University School of Medicine, 535 Barnhill Drive (RT041), Indianapolis, IN 46202. Tel: (317) 944-2425; Fax: (317) 944-2486; E-mail: jbuchsba@iupui.edu

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Anesthesia professionals are also subject to schedule pressures secondary to the vagaries of daily radiation oncology practice. To this is added the requirement for daily S/A for fractionated radiation therapy (RT) for anywhere from 1 to 8 weeks' duration, depending on disease site and histology. To our knowledge, very few studies have discussed institutional experiences with daily anesthesia during RT.

Proton treatment facilities introduce a new level of complexity to this already difficult logistical issue. Proton pediatric setup requirements are more time consuming (6) and complex than with photons (7). In addition, many US proton therapy centers are free-standing facilities without adjacent high-level hospital care. Anesthesiologists are placed in the sobering position of being required to function away from the controlled and familiar environment that supports the majority of their work (8).

The Indiana University Health Proton Therapy Center (IUHPTC) has developed an extensive pediatric referral base and expertise; as of May, 2012, 1 of every 7 patients ever treated at IUHPTC was 21 years of age or younger. Currently, 30% of patients under treatment are pediatric at the IUHPTC. Despite a distance of more than 50 miles from the academic center and 2 miles from the nearest hospital, we often have 2 children receiving S/A simultaneously on 2 separate gantries, with 2 separate anesthesiologists and a large, dedicated nursing support team. This is necessitated by a volume of up to 16 children requiring S/A for RT and/or treatment planning CT simulation scans each day.

The requirement that children receiving S/A have no oral intake before induction is an obvious trial for the parent and patient. With our patient volume, and the fact that keeping a child NPO past noon is extraordinarily difficult, we mitigate this by devoting mornings solely to children receiving S/A and trying to treat the youngest children earlier each day. In addition, as compared with most anesthesia events in other children, cases cannot be cancelled for minor illnesses such as upper respiratory tract infections (URI) or mild fevers. The anesthesiology team is asked to constantly review the risk of anesthesia compared with the risk of missing treatments, a task that at times is quite challenging. We are privileged to have a large cadre of understanding anesthesiologists who team with us for the daily care of these children. This manuscript describes our experience with repetitive pediatric anesthesia in an outpatient clinic setting.

Methods and Materials

This retrospective study was approved by the Indiana University School of Medicine institutional review board. Records of the IUHPTC were reviewed for patients receiving S/A between June 1, 2008, and April 12, 2012. Characteristics of this patient cohort are listed in Table 1. All subjects were pediatric patients under the age of 18 years. Each patient's chart included a collation of the daily anesthesia records, including the times of the procedure and any complications in the emergence process.

The IUHPTC is accredited by the American Association for Accreditation of Ambulatory Surgery Facilities, Inc, for the purpose of delivering anesthesia in an outpatient setting. This continuing accreditation ensures quality patient care in the non-hospital setting for procedures such as anesthesia and outpatient surgery.

All anesthesia procedures were performed by board-certified anesthesiologists using commercial anesthesia machines (Datex-Ohmeda, GE Healthcare, Madison, Wisconsin). All patients were consulted by an anesthesiologist on the same day as their radiation consultation. All anesthesia medications were used in standard fashion with dosing and administration directed by the anesthesia physicians. Induction of anesthesia with the parents/guardians present was in the proton radiation therapy treatment room. All patients had some means of central venous access. The typical induction for anesthesia was propofol 2.5 mg/kg given intravenously. We did see some propofol tolerance develop over time in some children and adjusted our induction dosages upward as needed in those select patients. After induction, an appropriate-sized Laryngeal Mask Airway (LMA) was placed, and maintenance of anesthesia was delivered with sevoflurane 3% and oxygen. Two children had tracheostomies with associated tracheostomy tubes. We used the tracheostomy tubes with a direct connection to the anesthesia circuit for inhalation induction and maintenance of anesthesia. Patients were monitored with telemetry consisting of respiratory tracking, single lead electrocardiogram, noninvasive blood pressure cuff, capnography with anesthetic gas analysis, pulse oximetry, and temperature monitoring by skin temperature crystal strips (Fig. 1). All patients with anesthetics lasting longer than 1 hour had active warming with a forced air total body warming blanket. Once patients had completed proton treatment, they recovered in a separate recovery room in the clinic. Some children had ports as central venous access devices that required needle insertion through the skin before use. These children had their central venous ports needle accessed on a Monday after an inhalation induction of sevoflurane. The central venous ports were left needle accessed during the week. To reduce the nuisance for weekend play time, the needle access to the ports were discontinued every Friday. Postanesthesia outcome and toxicity analysis included the period up to 24 hours after the patients were discharged from the procedures. Each proton beam treatment field was checked via on-board orthogonal kV images each day by a board-certified radiation oncologist in real-time before being delivered. Anesthesia used at patient simulation was purposely done, insofar as possible, in the exact

Table 1 Characteristics of the patient population

Gender	
Male	74
Female	64
Age (y)	
Median	All: 8.5; S/A: 4.2
Range	All pediatric patients: 1-17 (S/A 1-16)
No. of fractions	
Median	30
Range	1-49
Diagnosis	
	Medulloblastoma, 26
	Ependymoma, 25
	Rhabdomyosarcoma, 15
	PNET, 13
	ATRT, 12
Total time under anesthesia (min)	
Median	49.7
Range	30-90

Abbreviations: ATRT = atypical teratoid rhabdoid tumor; PNET = primitive neuroectodermal tumor; S/A = sedation/anesthesia.