

LETTER TO THE EDITOR

Open Access



Prevention of atelectasis secondary to propofol-based general anesthesia by application of continuous positive airway pressure to children with neuroblastoma undergoing computerized tomography: a quality improvement project

Rebecca D. Margolis¹, Sean J. Gamble², Jimmy J. Hoang² and Makoto Nagoshi^{1*} 

Atelectasis is a well-known complication of general anesthesia (GA) and intravenous propofol sedation [1–4]. Incidence of anesthesia-induced atelectasis is higher in younger age [4, 5]. In children with neuroblastoma, false uptake of metaiodobenzylguanidine (MIBG) in the lung due to atelectasis has been reported [6], which can obscure images of pulmonary metastases [7]. However, the incidence and severity of atelectasis in children receiving SPECT/PET/CT has not been delineated. Due to concerns of atelectasis confounding imaging quality in younger children, we implemented a new protocol to reduce atelectasis risk with continuous positive airway pressure (CPAP).

Methods

After IRB approval, imaging of children with neuroblastoma from the ages of 1 month to 10 years old was analyzed. Prior to the protocol change, we used an intravenous propofol infusion (150–250 mcg/kg/min) with nasal cannula. Following the protocol change, children's airway was supported with a laryngeal mask airway (LMA) or an anesthesia mask with a strap connected to a Jackson-Rees circuit (Fig. 1). Air blender ($FiO_2 < 30\%$) was used to prevent absorption atelectasis [8]. Higher propofol infusion rate (250–300 mcg/kg/min) was used to allow children to tolerate in situ airway. Air flow and AP valve in the circuit were adjusted to maintain CPAP (5 to 10 cmH₂O) [5]. We titrated infusion rate according to respiratory parameter

(SpO₂ > 95%) and hemodynamical parameter (mean arterial pressure above 40 mmHg).

A single, blinded pediatric radiologist graded the severity of atelectasis according to previously described scale [7] and determined whether there was significant atelectasis to confound image quality or not.

Statistics were calculated using McNemar's test due to paired observations from children receiving imaging both pre- and post-protocol implementation.

Results

Nine children underwent both pre- and post-protocol, but demographics of those at different time points of SPECT/PET/CT were very similar. The incidence of significant atelectasis in the "pre-protocol" sedation was 3/9 (33.3%) vs 0/9 patients (0.0%) in the "post-protocol" (p value = 0.04).

Discussion

Our observations among the nine children who underwent intravenous propofol infusion with and without CPAP at different time points showed a significant reduction in the incidence and severity of atelectasis with CPAP. Our new protocol is unique because we were able to achieve CPAP without the use of an anesthesia ventilator. The results of our study need to be considered in light of its limitations. Due to a small sample size and the retrospective nature of the study, we could not pinpoint the role of patient factors. The grading scale was developed by a single radiologist and has not been validated. We encourage larger, randomized studies to elucidate the effect of propofol anesthesia on the imaging

* Correspondence: mnagoshi@chla.usc.edu

¹Department of Anesthesiology Critical Care Medicine, Children's Hospital Los Angeles, Keck School of Medicine, University of Southern California, 4650 Sunset Boulevard, Los Angeles, CA 90027, USA

Full list of author information is available at the end of the article



Fig. 1 A child with anesthesia mask and head strap connected to Jackson-Rees bag maintaining CPAP

quality in the abovementioned patient population, as well as other cost-effective, reproducible methods to reduce the severity of atelectasis in this patient population.

In conclusions, adding CPAP to an intravenous propofol infusion using a Jackson-Rees bag and an air blender can decrease the incidence and severity of atelectasis in children and can be accomplished without an anesthesia machine.

Abbreviations

GA: General anesthesia; CPAP: Continuous positive airway pressure; CT: Computerized tomography; LMA: Laryngeal mask airway; MIBG: Metaiodobenzylguanidine; NC: Nasal cannula; PET: Positron emission tomography; SPECT: Single-photon emission computed tomography

Acknowledgements

The author gratefully acknowledge the contribution of Drs. Marla Matar MD, Anthony Romo MD, Samuel Yanofsky MD, Sam Saied MD, Andrew Costandi, Emily Chen MD, Karen Flotildes DO, Abhishek Karnwal MD, Neha Patel MD, Carl Lo MD, Jennifer Lau MD, Sang Le MD, Tiffany Frazee MD, Lydia Andras MD, and Elizabeth Bragg MD, Attending Anesthesiologists at Children's Hospital Los Angeles, CA, USA, for collecting clinical data. The authors also gratefully acknowledge the contribution of Dr Hollie Lai, Pediatric Radiologist at Children's Hospital of Orange County, CA, USA, for evaluating imaging of CT, Colleen Azen, biostatistician for biostatistics analysis.

Authors' contributions

SJG and JJH collected the data, performed statistical analysis with biostatistician's support, and drafted the manuscript. RDM and MN revised the manuscript. All the authors read and approved the final manuscript.

Funding

This work was supported in part by grants UL1TR001855 from the National Center for Advancing Translational Science (NCATS) of the US National Institutes of Health.

Availability of data and materials

They are available as electric files upon reasonable request.

Ethics approval and consent to participate

The study was approved by the Children's Hospital Los Angeles institutional review board (IRB; CHLA-16-00451) and was granted a waiver(s) of informed consent/assent/permission and a waiver of HIPAA authorization.

Consent for publication

All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Author details

¹Department of Anesthesiology Critical Care Medicine, Children's Hospital Los Angeles, Keck School of Medicine, University of Southern California, 4650 Sunset Boulevard, Los Angeles, CA 90027, USA. ²Present address: Department of Anesthesiology, Phoenix Children's Hospital, 645 E Missouri Ave, Suite 300, Phoenix, AR 85012, USA.

Received: 23 September 2019 Accepted: 5 November 2019

Published online: 25 November 2019

References

- Lam WW, Chen PP, So NM, Metreweli C. Sedation versus general anaesthesia in paediatric patients undergoing chest CT. *Acta Radiol.* 1998; 39(3):298–300.
- Lutterbey G, Wattjes MP, Doerr D, Fischer NJ, Gieseke J Jr, Schild HH. Atelectasis in children undergoing either propofol infusion or positive pressure ventilation anesthesia for magnetic resonance imaging. *Paediatr Anaesth.* 2007;17(2):121–5.
- Magnusson L, Spahn DR. New concepts of atelectasis during general anaesthesia. *Br J Anaesth.* 2003;91(1):61–72.
- Serafini G, Cornara G, Cavalloro F, Mori A, Dore R, Marraro G, et al. Pulmonary atelectasis during paediatric anaesthesia: CT scan evaluation and effect of positive endexpiratory pressure (PEEP). *Paediatr Anaesth.* 1999;9(3):225–8.
- Mahmoud M, Towe C, Fleck RJ. CT chest under general anesthesia: pulmonary, anesthetic and radiologic dilemmas. *Pediatr Radiol.* 2015; 45(7):977–81.
- Acharya J, Chang PT, Gerard P. Abnormal MIBG uptake in a neuroblastoma patient with right upper lobe atelectasis. *Pediatr Radiol.* 2012;42(10):1259–62.
- Sargent MA, McEachern AM, Jamieson DH, Kahwaji R. Atelectasis on pediatric chest CT: comparison of sedation techniques. *Pediatr Radiol.* 1999; 29(7):509–13.
- Edmark L, Auner U, Enlund M, Ostberg E, Hedenstierna G. Oxygen concentration and characteristics of progressive atelectasis formation during anaesthesia. *Acta Anaesthesiol Scand.* 2011;55(1):75–81.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen[®] journal and benefit from:

- Convenient online submission
- Rigorous peer review
- Open access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

Submit your next manuscript at ► [springeropen.com](https://www.springeropen.com)