JPPT | Case Series

Safety of Non-Operating Room Anesthesia With Propofol Sedation in Three Pediatric Patients With Central Sleep Apnea

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Children with central sleep apnea may require sedation for procedures, including brain imaging as part of the evaluation of apnea. However, the safety of deep sedation without a protected airway is not known in this patient population. In this case series, we present 3 children with central sleep apnea who were sedated with propofol for brain imaging in a non-operating room setting. All 3 did well with no complications; those with a home oxygen requirement were on oxygen during the procedure but none experienced apnea, desaturation, or respiratory distress. While obstructive sleep apnea is a known contraindication to deep sedation with propofol, it may be safe in pediatric patients with central sleep apnea. Deep sedation may be a good option for these patients, thereby avoiding the need for general anesthesia and placement of an advanced airway.

ABBREVIATIONS AAP, American Academy of Pediatrics; ASA, American Society of Anesthesiologists; CNS, central nervous system; CSA, central sleep apnea; $ETCO_2$, end-tidal carbon dioxide; GA, general anesthesia; GERD, gastroesophageal reflux disease; IV, intravenous; LMA, laryngeal mask airway; LPM, liters per minute; MRI, magnetic resonance imaging; NORA, non-operating room anesthesia; OSA, obstructive sleep apnea; $PaCO_2$, partial pressure of carbon dioxide; REM, rapid eye movement

KEYWORDS anesthesia; apnea; child; non-operating room anesthesia (NORA); patient safety; propofol

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Introduction

Central sleep apnea (CSA) is sleep-disordered breathing defined by an absence of respiratory effort. Patients with CSA have abnormal brainstem responses to changes in the partial pressure of carbon dioxide ($PaCO_2$) during sleep, causing transient apnea until $PaCO_2$ levels rise, which then prompts normal breathing to resume.[1–3]

Sedation in patients with CSA is considered challenging and the safety profile of different sedatives[4] and anesthetics in this patient population is not well known.[5] There is an even greater paucity of research surrounding children with CSA receiving sedation without the use of endotracheal intubation or a laryngeal mask airway (LMA). While there are some reports of pharmacologic agents used in adult patients with CSA, such as midazolam, ketamine, dexmedetomidine, propofol, nitrous oxide, and sevoflurane,[1,6–9] there has only been 1 report of a pediatric patient with CSA who received general anesthesia (GA) and endotracheal intubation for cardiac surgery using sevoflurane, ketamine, remifentanil and dexmedetomidine.[7] To our knowledge, there have been no prior reports of deep sedation in spontaneously breathing pediatric patients with CSA without a protected airway.

With the rise in procedural sedation outside the operating room by non-anesthesiologists, many procedures are moving away from general anesthesia (which may lead to reduced costs). Non-operating room anesthesia (NORA) can be very challenging, as clinicians may be in unfamiliar locations with inadequately trained staff, and they may be lacking medication, equipment, and monitoring devices when handling an emergency.[10,11] Propofol is a commonly used medication that works by prolonging the inhibitory effects of GABA and is increasingly utilized by multiple non-anesthesiology subspecialties including emergency medicine, hospital medicine, and critical care. Propofol has several advantages including its rapid onset, rapid recovery, and minimal side effects.[12,13] Some adverse effects of propofol include pain on injection, anaphylaxis, headache, hypotension, bradycardia, and transient apnea.[14] Obstructive sleep apnea (OSA) is a well-known contraindication to propofol sedation, as relaxation of the airway smooth musculature can precipitate obstructive events.[15] However, its safety in patients with CSA is unknown. The purpose of this case series is to investigate the effect of propofol in 3 children with CSA undergoing deep sedation for an MRI. All were undergoing MRI as part of the of evaluation of the CSA itself, which can be

caused by brainstem compression, such as with Chiari malformation.[16]

At our institution, pediatric hospitalists and intensivists provide NORA using propofol in the context of a dedicated sedation team that includes trained pediatric sedation nurses. For induction, our typical practice is a 0.5- to 1.0-mg/kg bolus dose of intravenous (IV) propofol administered by hand push, typically over 30 seconds, and this is repeated until induction is achieved. Immediately thereafter, a continuous 4 to 8 mg/kg/hr propofol infusion is started for the remainder of the procedure. The first propofol aliquot is mixed with lidocaine (1%) to minimize irritation of the vein; since this is standard it is not detailed in the below cases. Similarly, propofol boluses may be given when IV gadolinium contrast is administered by provider preference, and is also not detailed.

Standard monitoring includes continuous monitoring of the patient's heart rate (HR), respiratory rate (RR), pulse oximetry, and nasal end tidal CO_2 ($ETCO_2$) throughout the duration of the procedure. Additionally, vital signs, blood pressure (BP), and a Richmond Agitation-Sedation Scale rating (RASS) are documented at 5-minute intervals in the medical record. The sedation physician is present constantly during the procedure, 2 nurses are present during induction, and a nurse monitors the patient directly until recovery is complete. A pediatric sedation specific emergency cart, airway equipment box, suction, emergency medications, age-appropriate bag and mask, and supplemental oxygen are immediately available to the sedation physician and nursing staff in the event of an emergency. Pediatric anesthesiologists are available in the case of an emergency. Each patient is monitored for a period after completing their sedation (at least 30 minutes or until meeting discharge criteria), including assigning an Aldrete Postanesthesia Score, monitoring of vital signs as above, and assessing post-sedation nausea/vomiting, ability to ambulate/converse as appropriate, and tolerate oral fluids. Our institution utilizes standard discharge criteria as outlined in the 2019 American Academy of Pediatrics (AAP) guidelines for monitoring patients during sedation.[17]

Each patient undergoing propofol sedation is targeted for deep sedation. Per the 2019 AAP guidelines on monitoring during sedation, deep sedation is defined as a depressed state of consciousness where patients are not easily aroused but will respond purposefully to repeated verbal or painful stimulation.[17]

Case Reports

Case 1. An 11-month-old Caucasian female of 40 weeks' gestation with a history of congenital stridor and multiple apneic events (Table 1) presented for MRI of her brain. Her prior sleep study revealed episodes of CSA in rapid-eye-movement (REM) sleep unimproved by supplemental oxygen with a respiratory disturbance index of 3 events/hr. The respiratory events caused oxygen desaturations as low as 89%, and this was associated with 10 seconds of CSA. There was no clinically significant baseline nocturnal hypoxemia, hypercapnia, cardiac arrhythmia, periodic limb movement, excessive motor restlessness, or parasomnias observed. She was not placed on home oxygen based on these results.

Her weight was 8.7 kg and she was assigned an American Society of Anesthesiologists (ASA) class II by the sedation physician. Initially, 2.5 mg of midazolam was administered intranasally for IV placement, with unremarkable vital signs post-administration (Table 2). For the MRI, induction was carried out with four 1 mg/kg boluses of IV propofol over 2 minutes. Propofol infusion was then started at 8 mg/kg/hr for the remainder of the procedure and deep sedation was achieved. Her vital signs remained stable

Table 1. Past Medical History and ASA Physical Status Classification of Patients

Patient Number	Age, mo	Gestational Age at Birth, wk	Past Medical History	ASA Physical Status Class	O_2 Home Therapy (LPM)
1	11	40	Congenital stridor, CSA	Class II	None
2	9	39	OSA, CSA, laryngomalacia, GERD	Class III	½
3	33	41	Tonsillar hypertrophy, asthma, GERD, eczema, allergic rhinitis, recurrent supportive otitis media, CSA	Class III	¼

ASA, American Society of Anesthesiologists; CSA, central sleep apnea; GERD, gastroesophageal reflux disease; LPM, liters per minute; OSA, obstructive sleep apnea

throughout the procedure, with the only abnormality being low blood pressure for age, which is anticipated with propofol (Table 2). A total of 88 mg of propofol was administered over a sedation period of 43 minutes, after which the sedation was stopped. She did not require supplemental oxygen or interventions during the procedure. The post-sedation vital signs were stable, the airway patent, and oxygen saturation was greater than 92%. The range of vitals during infusion and recovery were also recorded (Table 2). She met discharge criteria with an Aldrete score of 10 (maximum value for this standard anesthesia recovery score is 10, indicating full recovery[18]), the ability to drink and protect her airway, and normal activity and mobility for age. She was discharged home after 46 minutes of monitoring post-sedation.

Case 2. A 9-month-old Caucasian female of 39 weeks' gestation with a history of severe OSA with hypoxia, laryngomalacia, and gastroesophageal reflux disease (GERD) presented for MRI of her brain (Table 1). She had a sleep study at 7 weeks of age that showed severe OSA with hypoxemia and SpO_2 in the low 80s. At 2 months of age, she had a supraglottoplasty, microlaryngoscopy, and bronchoscopy to correct her laryngomalacia. She had another sleep study at 19 weeks of age that showed a decrease in her apnea-hypopnea index from 39/hr to 19/hr. A third sleep study at 8 months of age showed continued OSA and new CSA with hypoxemia to the low 80s, improved by ½ liters per minute (LPM) of supplemental oxygen. There were 37 apneas seen, of which 3 were obstructive and 34 were central. There was no significant baseline nocturnal hypoxemia, hypercapnia, cardiac arrhythmia, periodic limb movement, excessive motor restlessness or parasomnias observed. Based on the results of the above studies, she was on ½ LPM of oxygen at home. As her sleep apnea appeared to be more central, with improvement in the obstructive component, she was deemed a candidate for sedation with propofol.

Her weight was 7.7 kg and she was assigned ASA class III by the sedation physician. 2.5 mg of midazolam was administered intranasally for IV placement. Vitals are shown in Table 2. Induction for the MRI was carried out with three 1 mg/kg boluses of IV propofol over 5 minutes. A propofol infusion was started at 7 mg/kg/hr for the remainder of the procedure and deep sedation was achieved. Vital signs remained appropriate except for lower BP for age, as expected. The patient did not have values recorded for $ETCO_2$ during infusion; a good waveform was seen throughout the procedure,

Table 2. Vitals Signs of Patients Upon Initial Presentation, After Receiving IN Midazolam for IV Placement, After Induction With Propofol, During Continuous Propofol Infusion, and During Recovery

Patient Number	Heart Rate, BPM	Respiratory Rate, breaths/min	Systolic Blood Pressure, mm Hg	Diastolic Blood Pressure, mm Hg	SPO_2,%	$ETCO_2$, mm Hg	Oxygen Applied (LPM)	Richmond Agitation-Sedation Scale
1*								
t_1	101	—	91	43	100	—	None	0
t_2	120	40	81	42	95	37	None	−4
t_3	119–123	35–39	75–79	32–39	94–97	31–39	None	−4
t_4	107–132	19–32	92–110	36–60	95–98	—†	None	—
t_5	132	19	110	60	95	—	None	—
2								
t_0	148	—	106	55	100	—	None	0
t_1	139	—	88	61	97	—	None	−1
t_2	127	24	85	41	100	50	1	−4
t_3	129–130	18–28	68–81	29–33	99–100	—	1	−4
t_4	114–148	22–31	71–91	29–71	97–99	—	1 → None	−4 → 0
t_5	148	31	71	45	99	—	None	—
3								
t_0	102	—	110	68	100	—	None	—
t_1	110	—	—	—	99	—	None	0
t_2	114	36	95	53	98	40	½	−4
t_3	102–108	27–34	81–93	31–43	96–100	43–47	½	−4
t_4	98–144	23–28	86–108	37–74	96–99	—	None	−4 → 0
t_5	144	25	108	74	99	—	None	—

BPM, beats per minute; $ETCO_2$, end-tidal carbon dioxide; LPM, liters per minute; t_0, initial vital signs; t_1, vitals post-midazolam; t_2, vitals post-induction; t_3, range of vitals during infusion (lowest to highest); t_4, vitals during recovery; t_5, vitals after recovery/final recorded.

*Patient 1 did not tolerate vital sign measurements prior to midazolam.
†$ETCO_2$ is typically removed during recovery.

but no numerical values were on the monitor due to a monitor error (Table 2). Because of the home oxygen requirement, she was started on 1 LPM of supplemental oxygen via nasal cannula while sedated, but did not have hypoxia, observed apneas, or respiratory distress. A total of 47 mg of propofol was administered over a sedation period of 39 minutes, after which the sedation was stopped. Her supplemental oxygen was discontinued without complication approximately 30 minutes after the end of the MRI. She had a recovery time of 42 minutes. The post-sedation vital signs were stable, the airway patent, and oxygen saturation was greater than 92%. The range of vitals during infusion and recovery were also recorded (Table 2). She met discharge criteria with an Aldrete score of 10, the ability to drink and protect her airway, and normal activity and mobility for age. She was discharged home after 42 minutes of monitoring post-sedation.

Case 3. A 2-year-old Caucasian female of 41 weeks' gestation with a history of tonsillar hypertrophy, asthma, GERD, eczema, allergic rhinitis, CSA, recurrent suppurative otitis media requiring bilateral tympanostomy tubes presented for MRI of her brain (Table 1). She had previously undergone a sleep study which showed significant CSA in REM sleep without hypoventilation, improved by ¼ LPM of supplemental oxygen. There was no significant baseline nocturnal hypoxemia, hypercapnia, cardiac arrhythmia, periodic limb movement, excessive motor restlessness or parasomnias observed. Based on these results, she was on ¼ LPM of oxygen at home.

Her weight was 15 kg and she was assigned ASA class III by the sedation physician. 4.5 mg of midazolam was administered intranasally for IV placement. Induction for the MRI was carried out with two 1 mg/kg boluses of IV propofol over 2 minutes. A propofol infusion was then started at 6 mg/kg/hr for the remainder of the procedure and deep sedation was achieved. Vitals remained appropriate except for lower BP for age, as expected (Table 2). Because of the home oxygen requirement, she was started on ½ LPM of supplemental oxygen via nasal cannula, but did not have hypoxia, observed apneas, or respiratory distress. She received 2 additional 0.5 mg/kg boluses of IV propofol during the procedure for patient movement, 1 just after starting the continuous infusion and 1 after receiving IV contrast. A total of 170 mg of propofol was administered over a sedation period of 90 minutes. She was weaned to room air without complication within minutes after the infusion was stopped. The post-sedation vital signs were stable, the airway patent, and oxygen saturation was greater than 92%. The range of vitals during infusion and recovery were also recorded (Table 2). She met discharge criteria with an Aldrete score of 10, the ability to drink and protect her airway, and normal activity and mobility for age. She was discharged home after 39 minutes of monitoring post-sedation.

Discussion

Our case series suggests that, with appropriate monitoring and with adequately trained providers, propofol may be a safe option in sedating children with CSA, as they can maintain spontaneous breathing without the use of an LMA or intubation. There are instances of tachycardia and some high BP during initial measurements and during recovery, as patients are often nervous or crying. Patients can also commonly have low BP, especially diastolic, during propofol infusion, so these are expected findings (Table 2). Overall, our patients did not have any complications associated with sedation, as their vital signs were stable, had patent airways, and oxygen saturations were greater than 92% on either room air or supplemental oxygen for those with a home oxygen requirement.

Central sleep apnea is seen in 1% to 5% of healthy children and 4% to 6% in children with an underlying condition, neurologic disorders being the most common.[19] Procedural sedation is being increasingly performed by pediatric hospitalists and intensivists. This requires continual growth of evidence that supports safe sedation while providing optimized care for patients, including those with CSA. Propofol has gained popularity over the past 2 decades for procedural sedation due to its rapid redistribution, rapid onset of action, and overall safety. In fact, while it is known to cause significant respiratory depression, its lipophilicity allows for a rapid onset of action in the brain, and then a rapid recovery due to its quick redistribution from the central nervous system into peripheral body compartments. Therefore, with appropriate safety measures, such as monitoring of vitals, a prepared emergency cart, airway equipment, and constantly present well-trained staff, propofol is a good choice for sedation in many situations, including potentially in patients with CSA.[12,13]

While there is some evidence suggesting that propofol is safe to use in adult patients with CSA, there is no prior literature regarding propofol use in pediatric patients with CSA. This case series supports its safety and use in these children, which is of particular importance as imaging of the brain is part of the evaluation for CSA itself. Of note, 2 of the 3 patients were on supplemental oxygen during sleep at home and were therefore also maintained on it during deep sedation. It is unclear if this was strictly necessary, but likely is best practice for patients with CSA to maintain patient safety. More studies will be needed to evaluate patients with a wider variety of ages, CSA severity, and undergoing different types of procedures.

Conclusion

We present 3 cases of children with central sleep apnea undergoing procedural sedation with propofol for a brain MRI who maintained spontaneous breathing. It is imperative that clinicians continue to implement

safe sedation practices to ensure quality patient care and limited adverse outcomes. While propofol is contraindicated in OSA, propofol did not cause apneic or respiratory events in these pediatric patients with CSA, suggesting that it may be a potentially safe option for use in this patient population. Further studies are needed to confirm propofol's safety in these patients undergoing procedural sedation.

Article Information

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