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Case Report Open Access

# High dose Dexmedetomidine and Ketamine for Managing Difficult Pediatric Airways

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**Abstract**

Dexmedetomidine is a useful drug to provide sedation and maintain spontaneous ventilation. Its use in pediatrics has increased over the last decade. Despite its utility as a cooperative sedative during difficult airway management in the adult population, this use in pediatrics is often not possible. As a result we present 3 cases of difficult pediatric airways that were secured using high dose dexmedetomidine and supplemental ketamine as sole agents. The patients achieved an appropriate depth of anesthesia, maintained hemodynamic stability and were able to breathe spontaneously during the airway manipulation.

## Introduction

Dexmedetomidine, a highly selective alpha 2-adrenoceptor agonist has been in use since 1999. Initial approval from the FDA was for sedation of adult patients who were intubated and mechanically ventilated. Despite lacking FDA approval for use in pediatrics its use has increased in children over a wide range of clinical scenarios [1-3]. In contrast to many anesthetic agents, dexmedetomidine preserves spontaneous ventilation, while providing analgesia and sedation [4]. It has been used in adults to help facilitate awake fiberoptic intubation using what is termed "cooperative" sedation [5]. In infants or toddlers or patients with a developmental disability, "cooperative" sedation is nearly impossible. Traditional sedatives such as benzodiazepines, opioids, and propofol can cause respiratory depression. Mask anesthesia with potent inhalational agents is contraindicated in patients with malignant hyperthermia susceptibility and can lead to airway obstruction and central apnea [6]. Ketamine is a drug that is known to induce a state of dissociated anesthesia, amnesia and analgesia while maintaining spontaneous ventilation [7]. By utilizing the unique properties of dexmedetomidine and ketamine, we provide an alternative technique of airway securement while maintaining spontaneous ventilation. We report three cases of difficult airway management in the pediatric population.

## Case Reports

### Case 1

The first patient was an 8 kg, 9-month-old infant that had developed drooling, fussiness, and difficulty feeding over the prior two days. The patient presented with fever to the emergency department, where a CT scan showed a large retropharyngeal abscess occupying about 1/3 diameter of the neck with significant edema and distortion of the upper airway (Figures 1 and 2).

The patient was scheduled for drainage of the retropharyngeal abscess. After discussing our plan of utilizing high dose dexmedetomidine and ketamine for fiberoptic intubation with the surgeon, we proceeded to bring the patient to the OR suite. Baseline vital signs were: blood pressure 110/65, heart rate 160, and oxygen saturation 100% via nasal cannula 2 liters. Standard ASA monitors were applied.

A dexmedetomidine bolus dose of 3 mcg/kg I.V. was administered over 10 minutes followed by an infusion of 2 mcg/kg/hr. After the dexmedetomidine bolus the patient's heart rate decreased to 130, and the blood pressure 110/60. The patient was maintained in a semi upright position with the head of bed elevated 30 degrees. Just prior to placing a fiber optic scope to the patients left naris, ketamine 1 mg/kg was administered to the patient. Vital signs at this point remained stable with blood pressure of 95/55, heart rate of 135 and oxygen saturation of 99% via 6 liters mask.

A 3.0 uncuffed endotracheal tube was gently placed in the patient's right naris and insufflated with oxygen at 10 L/minute. A 4.0 uncuffed nasal Rae tube was loaded on the fiber-optic scope and driven carefully down the left naris and maneuvered a difficult tortuous course through the nasal cavity and oropharynx. Once the glottic opening was visualized, lidocaine 1% was sprayed onto the vocal cords using the side channel on the fiberoptic-scope. Shortly thereafter, the endotracheal tube was advanced past the vocal cords and positioned in the mid trachea.

The patient was spontaneously ventilating throughout the placement of the endotracheal tube, without coughing or moving and maintained stable hemodynamics. The dexmedetomidine infusion was discontinued and a sevoflurane based anesthetic was utilized. Even though the patient tolerated the procedure well, he was kept intubated and transferred to the Pediatric Intensive Care Unit (PICU) postoperatively secondary to concerns of airway edema.

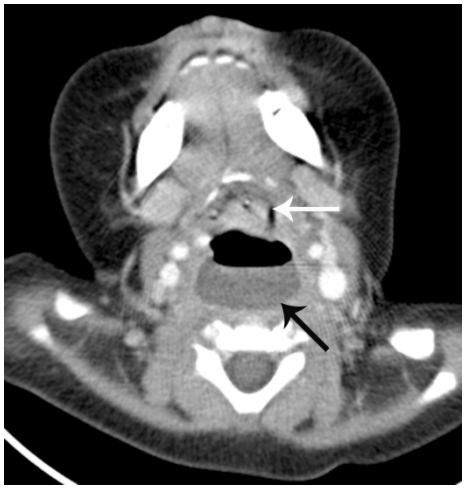

**Figure 1:** Axial CT image of the neck with contrast shows a rounded lesion with air-fluid abscess in the retropharyngeal space (black arrow) causing anterior displacement and effacement of the airway (white arrow).

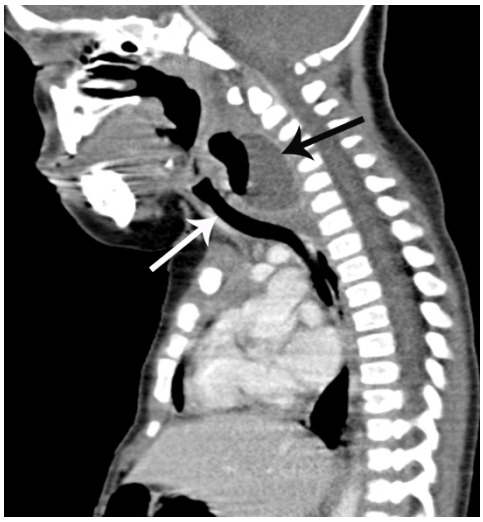

**Figure 2:** Sagittal CT image shows the anterior displacement of the airway (white arrow) and the retropharyngeal space abscess (black arrow).

## Case 2

The second patient was a 12 kg, 20-month-old previously well child, who presented to the Emergency Department with fever, cough and neck/facial swelling on the left side. She was admitted to the PICU for observation and scheduled for an incision and drainage of her neck mass the next day. A CT scan revealed a large abscess in the left neck at the level of C2-3 with extensive surrounding edema and probable phlegmon (Figure 3). During the late evening hours, the parent of child and nursing staff noted that the swelling in the child's lips, tongue and face were increasing and her mental status was progressively deteriorating. The anesthesia team was consulted to aid with airway management. Upon arrival to the PICU, the child was noted to be leaning forward, resting in her parent's lap. Her vital signs were stable, but on exam she had limited mouth opening, increased work of breathing and tense swelling of the floor of mouth and neck. A decision was made to transport the patient to the operating room for airway management. Her baseline vitals were: blood pressure 95/55, heart rate of 152, oxygen saturation of 99% via mask. Standard ASA monitors were applied. This child displayed a few signs of impending SIRS (tachycardia, fever, decreased mentation) therefore a smaller dose of dexmedetomidine was used compared to Case 1. A bolus dose of 2 mcg/kg I.V. was administered over 10 minutes followed by an infusion of 2 mcg/kg/hr. Following the dexmedetomidine bolus her heart rate decreased to 125, and blood pressure 90/50. Prior to direct laryngoscopy, ketamine 1 mg/kg IV was administered. At this point vital signs were: blood pressure 90/50, heart rate 130, and oxygen saturation of 100%. She maintained spontaneous ventilation throughout. With a proper depth of anesthesia the patient's mouth had relaxed, but direct laryngoscopy with a MAC 2 blade revealed a grade 3 Cormack-Lehane view. Therefore, a GlideScope video laryngoscope with a single use 2.5 detachable blade was then used to visualize the glottis opening where a grade 2 view was obtained; topical lidocaine spray was used to spray the glottis opening and a 3.5 micro cuff ETT was placed without difficulty. The patient was breathing spontaneously throughout the endotracheal tube placement and tolerated the procedure well. She was transferred back to the PICU without incident.

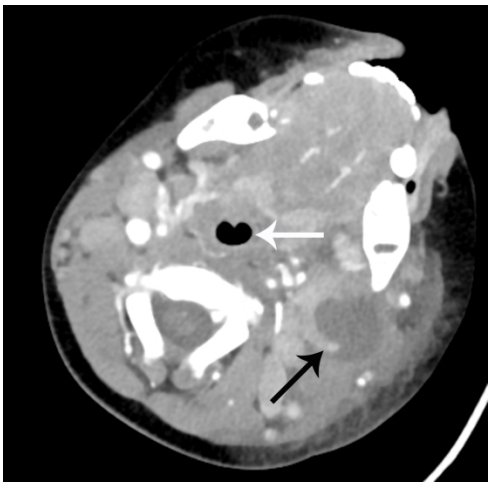

**Figure 3:** Axial CT image of the neck with contrast demonstrates an irregular hypodense lesion in the left parotid space (black arrow) known to be a phlegmon causing medial shifting of the carotid space and left parapharyngeal space and subsequent partial effacement of the left airway at the level of the pyriform sinuses (white arrow). The airway was mildly narrowed in this area.

## Case 3

The third patient was a 30 kg, 6-year-old female with Pierre Robin sequence, history of difficult intubation and mask ventilation and anaphylaxis to multiple antibiotics who presented to the hospital with a fever and urinary tract infection. Because of her past history of anaphylaxis to multiple classes of antibiotics, including an episode of anaphylaxis requiring emergency tracheostomy, she was brought to the operating room for a central line placement and airway securement.

The patient's baseline blood pressure was 130/70 with a heart rate of 90, oxygen saturation 98% on oxygen 6 L/min via facemask. Again, we elected to use a slightly smaller dose compared to Case 1, as this child displayed several signs concerning for SIRS (fever, elevated white blood cell count), thus dexmedetomidine bolus dose of 2 mcg/kg I.V. was infused over 10 minutes, followed by an infusion of 1 mcg/kg/hr. After the dexemedetomidine bolus her heart rate decreased to 80 and blood pressure 135/75. Just prior to video laryngoscopy, a ketamine bolus of 1 mg/kg IV was administered. Prior to intubation her vital signs were: blood pressure 148/80, heart rate 110, oxygen saturation 100%. A GlideScope video laryngoscope with a single use 2.5 detachable blade revealed a grade 2 view at which time we topicalized the glottic opening with lidocaine 4% and then placed a 5.0-cuffed endotracheal tube without any difficulty. After the airway was secured, the dexmedetomidine infusion was discontinued and a sevoflurane based anesthetic was employed. Following the procedure, the patient was transferred to the PICU, intubated and sedated.

## Discussion

Difficult or critical airways continue to be a challenge for anesthesiologists. However, with proper planning and training an anesthesiologist can control even the most challenging airways. Strict attention must be paid to drugs used to achieve conditions fit for intubation.

In the adult population, cooperative sedation has been used for decades to help facilitate awake fiberoptic intubations. In the last few years, dexmedetomidine has been utilized because of its sedative, anxiolytic and anti-sialagogue properties, all while maintaining spontaneous respiration; it has spurred the term cooperative sedation [5]. However, in the pediatric setting, infants, toddlers and developmentally delayed patients will not tolerate cooperative sedation. Conventional medications such as opioids, benzodiazepines and propofol carry the risk of respiratory depression and losing the airway.

High dose dexmedetomidine has been used as a sole agent during pediatric MRI with success [8]. However it must be noted that the hemodynamic effects of bradycardia and hypotension are not uncommon, but as the authors noted the majority of patients with bradycardia had heart rates that fell within 20% of age-adjusted values and the mean arterial pressure of those patients was always within 20% of age adjusted values [8]. When lower doses of dexmedetomidine have been used for noninvasive procedures it has been reported that re-bolusing and additional medications such as fentanyl and midazolam are needed to achieve proper sedation, and despite the lower doses there was a similar incidence in bradycardia and hypotension compared to the high dose regimen [9]. Despite a high incidence of hemodynamic changes with high dose dexmedetomidine, no interventions were needed [8,9]. Larger doses of dexmedetomidine with shorter infusion times may lead to hypertension too, since activation of peripheral alpha two receptors may lead to vasoconstriction, therefore it's prudent to infuse a bolus dose over a period of at least 10 minutes. One of the largest studies of children receiving high dose dexmedetomidine found the incidence of hypertension to be low (5%), but, interestingly, found that children under age 1 were more likely to develop hypertension [10]. High dose Dexmedetomidine (2-5 mcg/kg total doses) has been used successfully for invasive airway procedures in infants without significant hemodynamic instability [11]. Dexmedetomidine has also been used successfully with higher than standard doses as a sole agent in adult cases of complex airway anatomy [12]. Although these reports and data suggest success with dexmedetomidine as a sole agent, it has not been uniformly successful for invasive procedures [13-15]. However, there are several reports of using dexmedetomidine in combination with ketamine for more invasive procedures [16-18].

Ketamine's sympathomimetic properties may offset the bradycardia and hypotension that have been reported with dexmedetomidine [16]. Ketamine also possesses analgesic properties while generally maintaining airway reflexes and respiratory drive. Increased secretions, a common adverse effect of ketamine, and emergence phenomena are offset by dexmedetomidine [17-20]. To date there are limited prospective trials in the pediatric population evaluating the efficacy of combined dexmedetomidine and ketamine for procedural sedation.

The doses used in this case series were derived from a synthesis of the current literature combined with our personal experience. Mason et al. [8] describe increased success rate with a higher dose of dexmedetomidine for noninvasive procedures such as MRI. Dexmedetomidine used at lower doses for noninvasive procedures have resulted in a need for additional medications such as fentanyl and midazolam, which can lead to respiratory depression [9]. Iravani and Wald [17] describe the successful use of dexmedetomidine and ketamine for a fiberoptic intubation in a child with Treacher Collins syndrome, but used a lower dose dexmedetomidine (1 mcg/kg) and ketamine (0.25 mg/kg), which had to be repeated 5 times [14]. Shukry and Kennedy [11] reported the use of dexmedetomidine as a total intravenous anesthetic in infants during invasive procedures of airway manipulation at doses of 2-5 mcg/kg of without significant hemodynamic compromise.

Our doses are higher than previously reported in the pediatric population for airway securement, but resulted in stable hemodynamics and an excellent depth of anesthesia to instrument the airway.

## Conclusion

High dose dexmedetomidine combined with ketamine appear to be a useful drug combination for securing difficult airways of infants, toddlers and developmentally challenged patients while maintaining spontaneous ventilation. The technique we describe provides an alternative to classic sedative agents such as propofol and benzodiazepines as well as inhaled mask anesthesia, which can lead to apnea and/or airway obstruction unless carefully titrated. Additionally, with a continuous infusion, one can provide uninterrupted anesthesia while the airway is instrumented.

Although the patients in this case series maintained hemodynamic stability, we do not recommend using these doses in children who are hypovolemic, in septic shock or have congenital heart disease. Furthermore, caution must be exercised in children taking medications that affect heart rate such as beta-blockers and calcium channel blockers. Additional studies are needed to further elucidate ideal dosing and hemodynamic effects of this combination of drugs.

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