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MRI Sleep Studies: Use of Positive Airway Pressure Support in patients with Severe Obstructive Sleep Apnea

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Abstract

Maintaining the patency of the upper airway during MRI sleep studies without an artificial airway placement in sedated or anesthetized patients with severe obstructive sleep apnea (OSA) is a major challenge. We report two cases in which a continuous positive airway pressure (CPAP) was used instead of artificial airway to allow interpretation of the dynamic component of the study.

Keywords

obstructive sleep apnea; MRI sleep studies interpretation, upper airway obstruction; airway intervention; positive pressure breaths; continuous positive airway pressure

Introduction

Examination of patterns of dynamic airway collapse in patients with obstructive sleep apnea (OSA) permits identification of underlying anatomic causes of airway obstruction and facilitates optimizing surgical intervention required to relieve airway obstruction. Magnetic resonance imaging (MRI) sleep studies have been reported to successfully depict airway motion abnormalities that are related to OSA.¹ It has also shown that there is greater chance of successfully treating OSA when sleep cine MRI are used to guide surgical decisions, as

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compared to when they are not². Obtaining a high quality dynamic airway imaging study is critical for accurate interpretation and subsequent planning for treatments required to relieve airway obstruction. The most common challenge faced during sleep MR airway imaging studies is the inability of the child breathing via the native airway to tolerate an adequate level of sedation or anesthesia without experiencing significant oxygen desaturation. Artificial airway placement, either a nasal trumpet or oral airway, is occasionally required to safely complete the study (Figure 1A). The presence of the artificial airway distorts the airway anatomy and compromises interpretation of the dynamic component of the study, complicating clinical decision making. Continuous positive airway pressure (CPAP) can be an effective airway intervention that maintains and improves upper airway patency and can treat sedation-induced airway obstruction by increasing pharyngeal dimensions and by reducing pharyngeal lateral wall collapse³. Application of CPAP in patients with severe OSA provides a way to support patient who might be desaturating during a sleep MRI, while at the same time allowing for a full, more clinically useful evaluation of the patient's airway obstruction.

Case description

Two patients, both with a history of OSA were referred for MRI sleep study evaluations. In both cases, insertion of an intravenous catheter was facilitated by inhalation of sevoflurane and nitrous oxide. Anesthesia was maintained with propofol for the first patient and dexmedetomidine infusion for the second patient while the patient breathed spontaneously.

Patient 1

A 5-YR-OLD male, presented for sleep MRI evaluation due to persistent, severe OSA despite prior adenotonsillectomy. He has a history of Down syndrome and despite extensive efforts, he refuses to wear the CPAP mask. Polysomnography (PSG) report showed that the obstructive apnea/hypopnea index (AHI) was 34 and the lowest oxygen saturation was 79%. The anesthesia providers placed a nasal airway when the oxygen saturation reached 88%. Subsequently, despite the artificial airway, the patient continued to have oxygen desaturations into the 80s. At this point, a face mask CPAP at 3 cm of water pressure was applied, stabilizing oxygen saturation in the 90% range throughout the MRI exam.) MRI demonstrated glossoptosis, macroglossia, enlarged lingual tonsils and recurrent adenoid. Additionally, the retroglossal airway was collapsing dynamically during breathing. Due to the findings on the MRI, the patient underwent a midline posterior glossectomy, revision adenoidectomy, and a lingual tonsillectomy. On follow-up PSG 3 months later the patient AHI was 1.2.

Patient 2

The second patient was a 7-year-old-female with asthma referred for imaging due to severe OSA and poor sleep with CPAP. Three years earlier, she had undergone adenotonsillectomy for snoring, but continued to have snoring and problems with falling asleep at school, on the bus and during meals. A PSG was performed revealing an AHI of 103 events per hour. CPAP was initiated, but this was poorly tolerated with frequent arousals during the night and persistent oxygen desaturations at a CPAP pressure of 10 cm of water pressure. The patient was referred for a sleep cine MRI. Due to concerns about the degree of airway compromise,

both Radiology and Anesthesia were consulted prior to general anesthesia by the patient's physician and the decision to proceed with using CPAP to maintain the airway during imaging was made. After anesthesia induction, a modified nasal CPAP at 10 cm of water pressure was applied. Initial localizer images were performed, followed by end inspiratory triggered 3D proton density weighted sequence was performed uneventfully (Figure 1B). Midline sagittal and axial (Figure 2) cine imaging was performed for evaluation of airway dynamics using both 10 cm of CPAP pressure as well as similar cine imaging done with no CPAP. The cine imaging done without positive pressure support took approximately 2 minutes. Both cine MRI images revealed hypopharyngeal collapse with static glossoptosis and recurrent, enlarged adenoids. Due to the hyperdynamic hypopharyngeal collapse of the airway (Figure 2) and the static posterior position of the tongue, revision adenoidectomy and genioglossus advancement was performed. Repeat PSG eight weeks later showed a normal AHI of 0.9 events per hour.

Discussion

It is well established that upper airway collapsibility is markedly increased in both sleeping and anesthetized children.⁴ Anesthetic agents impair the ability of the upper airway muscles to overcome the negative pressures during inspiration, resulting in increased upper airway resistance and predisposing the patient to obstructive events, particularly in the retro-palatal region. Patients with severe OSA represent a major challenge due to significant oxygen desaturation under anesthesia. There is no strict consensus among anesthesia providers regarding when to interrupt airway imaging for interventions to improve oxygenation⁵. Absolute lower limits of oxygen saturation below which artificial airway adjuncts are required may differ from patient to patient depending on the benefits to be gained from the imaging study and the severity of the patient's condition. Overnight polysomnography noting the severity of desaturations during natural sleep can be used by the anesthesiologist as a guide to determine minimal acceptable arterial oxygen saturation before intervention. Insertion of an artificial airway is performed at the discretion of the attending anesthesiologist. A reasonable approach, in general, is to not intervene in patients with mild OSA until oxygen saturation are <90%, while patients with moderate or severe OSA are allowed to oxygen saturation levels of <85% before intervention. Many of the patients experience this type of desaturation during polysomnography. In our experience, the need for artificial airway support during MRI sleep study is significantly less with dexmedetomidine compared to sedation with propofol⁶.

Interpretation of the sleep MRI with an artificial airway present is problematic because the artificial airway distorts anatomy, but more importantly effects changes in the natural behavior of the airway observed on cine imaging. In most cases, the presence of an artificial airway significantly decreases the usefulness of the MRI evaluations, particularly the cine images. A small number of studies have been performed in the past with an adjunct airway in place, including sagittal and axial cine. Subsequently, the airway is removed and repeat cine imaging performed at the end of the study. Utilizing a small amount of CPAP instead of an artificial airway has advantages for both the anesthesiologist and the radiologist. The CPAP provides a safer study for the patient and eliminates distortion of the airway anatomy caused by the rigid artificial airway. In these two patients, where imaging was done with and

without CPAP support, there was no significant changes in the dynamic movement, degree of collapse, nor any change in the relative position of structures or airway narrowing. Most importantly, CPAP did not appear to change the underlying motion of the airway and collapse could still be observed (Figure 2 and supplement cine images). Compared to an artificial airway, with CPAP, the anesthesiologist can adjust the positive pressure used without disturbing the patient and there is no need to remove the patient from the bore of the magnet.

Because of the complexity of these studies, we highly recommend a team approach with good communications between the radiologists, ordering physician, imaging technicians and the anesthesiologist who are involved in the care of these children. There is a definitely a learning curve with these studies and the team. Currently, not enough cases requiring CPAP have been performed to demonstrate a quantifiable preference among radiologists or anesthesiologist. We report our experience of using CPAP during airway imaging for two patients with OSA. Further studies are warranted to elucidate the limitations and reproducibility of this technique.

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Figure 1.

Sagittal Midline MR With and Without Nasal Airway.

Midline image obtained with 3D FSE (proton density) with end inspiratory respiratory gating. A, Typical patient with an adjunct nasal airway (arrowheads), which is visible on the MR only as an area of signal void pressing on and distorting anatomy. B, Anatomic structures are shown without distortion of adjunct nasal airway in patient 2 who was supported with CPAP 10 cm. Adenoids are large and causing narrowing of the nasopharyngeal airway (arrows). The tongue is not enlarged, but is falling back narrowing the retroglossal airway (arrow).

Figure 2.

Dynamic Changes of the Airway during Respiration.

Selected images from an axial SSFP real-time cine image through the retroglossal airway in patient 2 illustrates the dynamic motion of the airway. A, Expiratory and B, inspiratory phase images of the retroglossal airway at 10 cm of CPAP (arrowheads show the anterior, posterior and lateral margins of the airway). Image B shows the collapsed airway. C and D, Shows the same phases of the airway with CPAP at 0 cm of water. A sagittal and axial movie of this airway can be viewed at supplemental online images.