

Improving Outcomes in Pediatric Obstructive Sleep Apnea With Computational Fluid Dynamics

Status: RECRUITING

Eligibility Criteria

Sex: ALL

Age: 3 years to 18 years old

Healthy Volunteers: This study is NOT accepting healthy volunteers

Inclusion Criteria:

- Male or Female
- Subjects between the ages of 5 to 18 only for Aim 1 and xenon use
- Subjects 3-18 years of age for Aims 2 and 3
- Subjects with persistent moderate or severe OSA after adenotonsillectomy. - -- Persistent moderate or severe OSA will be defined as an oAHI > 5 per hour of sleep.
- Clinical indication or suspicion of upper-airway obstruction. Examples include but not limited to hypertrophy of the lingual tonsils, disproportionately large tongue, or micrognathia.
- Subjects who have failed a trial of CPAP.
- Subjects whose parents elect to pursue surgery without a trial of CPAP.
- Subjects who require a surgical procedure for OSA based on the clinical assessment of the surgeon (otolaryngologist or plastic surgeon).

Exclusion Criteria:

- Children adequately treated with CPAP.
- Children with braces/metal rods.
- Children who have a contraindication to sedative.
- Standard MRI exclusion criteria as set forth by the CCHMC Department of Radiology.

Conditions & Interventions

Interventions:

DRUG: 129-Xe

Conditions:

Obstructive Sleep Apnea

Keywords:

OSA, 129Xe, MRI, CFD simulations

More Information

Description:

To create a validated computational tool to predict surgical outcomes for pediatric patients with obstructive sleep apnea (OSA). The first line of treatment for children with OSA is to remove their tonsils and adenoids; however, these surgeries do not always cure the patient. Another treatment, continuous positive airway pressure (CPAP) is only tolerated by 50% of children. Therefore, many children undergo surgical interventions aimed at soft tissue structures surrounding the airway, such as tonsils, tongue, and soft palate, and/or the bony structures of the face. However, the success rates of these surgeries is surprisingly low. Therefore, there is a need for a tool to improve the efficacy and predict which surgical option is going to benefit each individual patient most effectively. Computational fluid dynamics (CFD) simulations of respiratory airflow in the upper airways can provide this predictive tool, allowing the effects of various surgical options to be compared virtually and the option most likely to improve the patient's condition to be chosen. Previous CFD simulations have been unable to provide information about OSA as they were based on rigid geometries, or did not include neuromuscular motion, a key component in OSA. This project uses real-time magnetic resonance imaging (MRI) to provide the anatomy and motion of the airway to the CFD simulation, meaning that the exact in vivo motion is modeled for the first time. Furthermore, since the modeling is based on MRI, a modality which does not use ionizing radiation, it is suitable for longitudinal assessment of patients before and after surgical procedures. In vivo validation of these models will be achieved for the first time through comparison of CFD-based airflow velocity fields with those generated by phase-contrast MRI of inhaled hyperpolarized 129Xe gas. This research is based on data obtained from sleep MRIs achieved with the subject under sedation. While sedating the patient post-operatively is slightly more than minimal risk, the potential benefits to each patient outweigh this risk. As 58% of patients have persistent OSA postsurgery and the average trajectory of OSA severity is an increase over time, post-operative imaging and modeling can benefit the patient by identifying the changes to the airway made during surgery and which anatomy should be targeted in future treatments.

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