The Laryngoscope

How I Do It

Pediatric Modifications to Hypoglossal Nerve Stimulation for Obstructive Sleep Apnea: How I Do It

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INTRODUCTION

Hypoglossal nerve stimulation (HGNS) is an established surgical treatment for refractory moderate-to-severe obstructive sleep apnea (OSA) in adults attributable to isolated tongue base collapse.[1] The indications for this procedure are continuing to expand, and a Food and Drug Administration (FDA) trial is currently underway evaluating the utility of HGNS in the Down syndrome population.[2,3] This population has a high incidence of refractory OSA that likewise is commonly due to isolated tongue base collapse.[4] The preliminary results from this clinical trial suggest that indications for HGNS may soon be expanding to children.[5] Although the operative steps of HGNS are well described in adults, the surgical modifications necessary to conduct this procedure in the pediatric population have not been previously elucidated. The authors present their experience with pediatric hypoglossal nerve implantation.[6,7]

METHODS

A retrospective chart review was performed of all pediatric hypoglossal nerve implants done by the senior author (C.J.H.) at a single institution from 2015 to 2019. All patients in this report were part of the FDA-approved clinical trial to evaluate the utility of the HGNS in children with Down syndrome. This study is registered with ClinicalTrials.gov (NCT2344108) under the title "A Pilot Study to Evaluate the Safety and Efficacy of the Hypoglossal Nerve Stimulator in Adolescents With Down Syndrome and Obstructive Sleep Apnea." This study was approved under investigational device exemption G140209. This study has been approved by the institutional review board at the Massachusetts Eye and Ear Infirmary at Partners Healthcare (Boston, MA, USA).

SURGICAL TECHNIQUE

Preparation and EMG Placement

The patient is prepped and draped in the standard fashion and intubated with an age-appropriate nasotracheal tube through the left nare. Electromyography (EMG) leads are placed in the genioglossus and hyostyloglossus muscles using Prass-paired (Medtronic, Dublin, Ireland) 18 mm electrodes. During sterile preparation, it is important to use a translucent sterile drape (3M, St. Paul, MN) (10-10/Ioban) to allow for visualization of the tongue and electrodes during device interrogation.

Incision Modification

A 4 cm transverse submental incision is made approximately 0.5 cm from the midline and 1 finger breadth below the mandible. A 5 cm incision should be made over the fourth to sixth rib for both the pleural sensing lead as well as insertion of the implantable pulse generator (IPG). This is different than adult implantation, for which three separate incisions are made.

IPG Pocket Modification

Prior to the insertion of any leads, the pocket for IPG placement is dissected. The incision is made in the chest site (not a third incision, as described in the adult literature) to identify the pectoralis fascia. In children, the third infraclavicular incision for IPG placement is not necessary and therefore is spared. A plane is created superficial to the pectoralis fascia and extended superiorly to about 2 to 3 cm below the clavicle. This technique is best completed with a lighted breast retractor and extended Colorado needle tip cautery. Prior to implanting the IPG, the sensor and stimulation leads are placed.

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Sensor Lead Insertion Modifications

Through the previously dissected chest incision, taking care to stay just superior to rib to avoid the neurovascular bundle, a plane is dissected between the internal and external intercostal muscles with the help of a small malleable retractor. The sensor lead is placed into this site, advancing laterally into the intercostal tunnel. This is not advanced medially, as described in the adult literature, because the sensor may pick up artifact secondary to cardiac motion. The sensor lead is then anchored down in the typical fashion.

Stimulation Lead Insertion Technique

The hypoglossal nerve is identified. As the dissection is mobilized anteriorly, the medial branches to the genioglossus and geniohyoid should be identified for inclusion. The main branch point at which lateral and medial branches occur should be noted, and EMG monitoring should be used to assess for any exclusion nerve fibers with a late branch point. Once late branches have been excluded, a right-angle dissection can be used to dissect circumferentially around the nerve to create a tunnel underneath the nerve through which an additional vessel loop can be used to facilitate identification of inclusion branches and provide gentle retraction. Angled forceps and a right-angle dissector are used to pass the stimulation lead cuff circumferentially around the exposed nerve. The electrode is then anchored to the digastric tendon.

Lead Tunneling, IPG Insertion, and Closure

First, a trochar is inserted from the chest incision and tunneled up to the neck incision. Because there is no infraclavicular incision, or halfway point, it is important to maintain constant palpation of the clavicle as a landmark to ensure appropriate tunneling of the trochar superficial to the clavicle and into the neck incision itself. Once the distal tip of the trochar is in the neck incision, the stimulation lead is then attached to the trochar and tunneled inferiorly down to the chest incision, and then both the stimulation and sensor lead are inserted into the IPG similar to the adult technique. The device is interrogated to ensure the tongue protrudes in an acceptable manner. Because there is no infraclavicular incision to secure the device in a traditional way, two 3–0 silk sutures are used to tack the device to the pectoralis fascia. First, the sutures are thrown into the pectoralis fascia using a long-handled needle driver to ensure that the sutures are secured at the level of the superior aspect of the flap raised from the chest incision. After these sutures are tacked to the pectoralis fascia, only then are they inserted into the IPG and then tied down through the chest incision. If the sutures are secured at the superior extent of the raised flap, they should pull the IPG superiorly as they are tied down. The incisions are then closed in a multilayered fashion. A Tegaderm (3M, St. Paul, MN) and nonocclusive gauze over the submental incision is left in place for 7 days. A postoperative chest film is completed to rule out pneumothorax.

RESULTS

Overall, 23 patients met criteria for inclusion and were implanted with a hypoglossal nerve stimulator (Supporting Information Video S1). No major complications (cardiopulmonary, pneumothorax, wound infection, device infection, or device failure) were experienced by any of the children in the study.

DISCUSSION

Based on our collective experience, these modifications to the adult technique of hypoglossal nerve stimulator implantation enhance both the safety and efficacy of this procedure in the pediatric population. We acknowledge that all children in this case series had Down syndrome; however, the modifications described are not necessarily Down syndrome-specific but rather are applicable to all children. We also recognize that HGNS is not the only mechanism available to treat OSA attributable to tongue base collapse in the pediatric population. Such children also can be considered for lingual tonsillectomy, posterior midline glossectomy, tongue suspension suture, epiglottopexy, tongue-lip adhesion, and hyoid suspension.[8]

CONCLUSION

Pediatric HGNS is a safe and effective way to treat moderate to severe OSA with isolated tongue-base collapse. A few straightforward modifications to the adult technique when performing surgery on a pediatric patient can facilitate safe surgery in this vulnerable population.

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This study is registered with ClinicalTrials.gov (NCT2344108) under the title “A Pilot Study to Evaluate the Safety and Efficacy of the Hypoglossal Nerve Stimulator in Adolescents With Down Syndrome and Obstructive Sleep Apnea.” This study was approved under investigational device exemption G140209.

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