International Journal of Pediatric Otorhinolaryngology 75 (2011) 1234–1239

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Changes in sleep apnea after supraglottoplasty in infants with laryngomalacia

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ARTICLE INFO

Article history:
Received 16 March 2011
Received in revised form 25 June 2011
Accepted 27 June 2011
Available online 3 August 2011

Presented at the 2010 AAO-HNSF Annual Academy Meeting Scientific Session in Boston, MA

Keywords:
Laryngomalacia
Polysomnography
Obstructive sleep apnea

ABSTRACT

Objective: To determine the clinical and polysomnography outcomes in infants with laryngomalacia undergoing supraglottoplasty.
Methods: Infants (<1 year old) who underwent polysomnography pre- and post-supraglottoplasty at our tertiary referral center between 2003 and 2009 were reviewed retrospectively. Outcome measures included changes in stridor, sleep disordered breathing, swallowing, and polysomnography parameters before and after surgery. Pre- and postoperative distributions were compared using a Wilcoxon signed-rank test.
Results: 20 children met inclusion criteria. Statistically significant improvements were found in pre- to postoperative median values for apnea-hypopnea index (AHI) (median change: −6.4 points, $p = 0.02$) and obstructive apnea index (median change: −2.9 points, $p = 0.01$) values. Obstructive AHI, O_2 saturation nadir, and percentage of sleep spent with <90% O_2 saturation improved, although not significantly. Postoperative AHI scores correlated with improvements in stridor in 80% of patients. Stratification showed similar improvements in AHI after supraglottoplasty regardless of reflux treatment, secondary airway lesions, age at supraglottoplasty, or time lag between supraglottoplasty and postoperative polysomnography. Secondary airway lesions are the only potential confounders shown to have significantly better improvements in O_2 nadir. While the sleep study improved in patients with AHI >5, infants with AHI <5 had worse polysomnography parameter values postoperatively. Five patients had dysphagia that resolved within one month postoperatively; otherwise, supraglottoplasty resulted in no complications.
Conclusion: Supraglottoplasty may be an effective and safe option to improve moderate to severe obstructive sleep apnea in infants with laryngomalacia. In addition, polysomnography may be useful in infants with laryngomalacia to identify obstructive sleep apnea and/or to objectively measure outcomes after supraglottoplasty. This pilot study warrants a larger, prospective, and controlled study to validate these findings.

1. Introduction

Although often overlooked, the most common cause of laryngeal obstruction in infants, laryngomalacia (LM), has been shown to be a source of significant obstructive sleep apnea (OSA) [1–3]. While the true incidence of OSA in infants with LM is unknown, it has been reported in up to 100% of patients undergoing supraglottoplasty (SGP) for severe LM [1,2]. Patients with less severe LM have also been shown to suffer from significant OSA and benefit from SGP [3]. Polysomnography (PSG) is considered to be the "gold standard" in diagnosing OSA and a useful objective outcome measure after SGP in these patients [1–3]. Definitive guidelines regarding the role of PSG in evaluating patients with LM, however, have not yet been established. Likewise, the use of SGP to treat OSA in the setting of LM is not well understood. In this study, we present our experience using pre and postoperative polysomnorgaphic parameters to evaluate the affect a SGP has on OSA in infants (<1 year old) with severe LM.

2. Methods

With institutional review board approval, a retrospective chart review of infants with LM treated at our institution between 2003 and 2009 was performed. Inclusion criteria included patients less than one year of age who underwent PSG pre- and post-SGP. Two subgroups were analyzed according to their surgical indication. The first group had "severe" LM and presented with failure to thrive or signs of severe respiratory distress, such as cyanotic spells, severe retractions, or prolonged apneas with significant

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0165-5876/$ – see front matter
doi:10.1016/j.ijporl.2011.06.021

desaturations while awake. The second group had "moderate" LM with stridor and associated retractions or dysphagia but none of the characteristics of severe LM. Patients with moderate LM underwent SGP if moderate to severe OSA (AHI >5) was present.

The diagnosis of LM was made during awake fiberoptic evaluation and the LM contribution to sleep apnea was confirmed under general anesthesia. Children were induced with sevoflurane (5%) in 100% oxygen. While the patient is spontaneously breathing, intravenous (IV) access is obtained. The administration of sevoflurane is then reduced or stopped as the surgeon then performs laryngoscopy. As the child exhales sevoflurane, the concentration of the gas decreases in the brain quickly and rapid lightening up of the anesthetic occurs. As the child then nears stage II anesthesia, dynamic breathing and pharyngo-laryngeal muscle movements are examined. Occasionally small doses of IV propofol are needed for the child to tolerate direct laryngoscopy.

Endoscopy is performed via two methods. One way was to introduce a vallecular laryngoscope gently elevating the tongue to expose the larynx. A zero degree or 30 degree telescope is used to capture and record laryngeal dynamics. Once effortful breathing is achieved the laryngoscope's elevation of the tongue base is relaxed and supraglottic dynamics are examined. The laryngoscope may be completely removed in younger children, while maintaining the rigid telescope in place. Fig. 1A and B illustrates a typical case of a normal airway during expiration and laryngeal obstruction during inspiration. Endoscopy also was performed by introducing a flexible laryngoscope via the nasal cavity to examine the supraglottic airway. While the child is inhaling sevoflourane, the flexible laryngoscope is introduced via the nasal cavity and advanced to examine the supraglottic larynx. This procedure was done at a lighter level of anesthesia and at times provided a better assessment of airway dynamics.

Once the decision is made to proceed with a laser SGP, the patient's level of anesthesia is deepened by using a combination of propofol IV and a narcotic such as fentanyl. All procedures were performed by the senior author (GPD). A SGP is performed under spontaneous ventilation though with significantly decreased dynamics. The procedure begins by first dividing the aryepiglottic folds using laryngeal scissors (Fig. 1C). The carbon dioxide laser is then used at the lowest setting possible (typically at 1.5 W – superpulse) to remove the redundant supraglottic mucosa along with the superior portion of the cuneiform cartilage (see Fig. 1D). Care is taken to avoid injury to intra-arytenoid space. In all cases the procedure was performed bilaterally. A twice daily proton pump inhibitor was given to the patient for a minimum of one month after surgery, and steroids were occasionally administered for less than 24 h postoperatively. Patients were evaluated in the clinic after one week, after repeat PSG, and then as needed. Dysphagia before and after surgery was also noted. If parents expressed concern for the patient's ability to tolerate oral intake or there was not appropriate weight gain the child was referred for a videofluoroscopic swallow study (VSS) and evaluation by speech and language pathology.

Pediatric PSG studies took place at our children's hospital and were read by a pediatric sleep specialist. The changes in PSG parameters before and after SGP were analyzed. The PSG parameters used to define and classify OSA is variable in the literature, with apnea-hypopnea index, obstructive apnea index, and obstructive apnea-hypopnea index being the most commonly used measures [4–8]. In our institution, OSA is classified as mild if

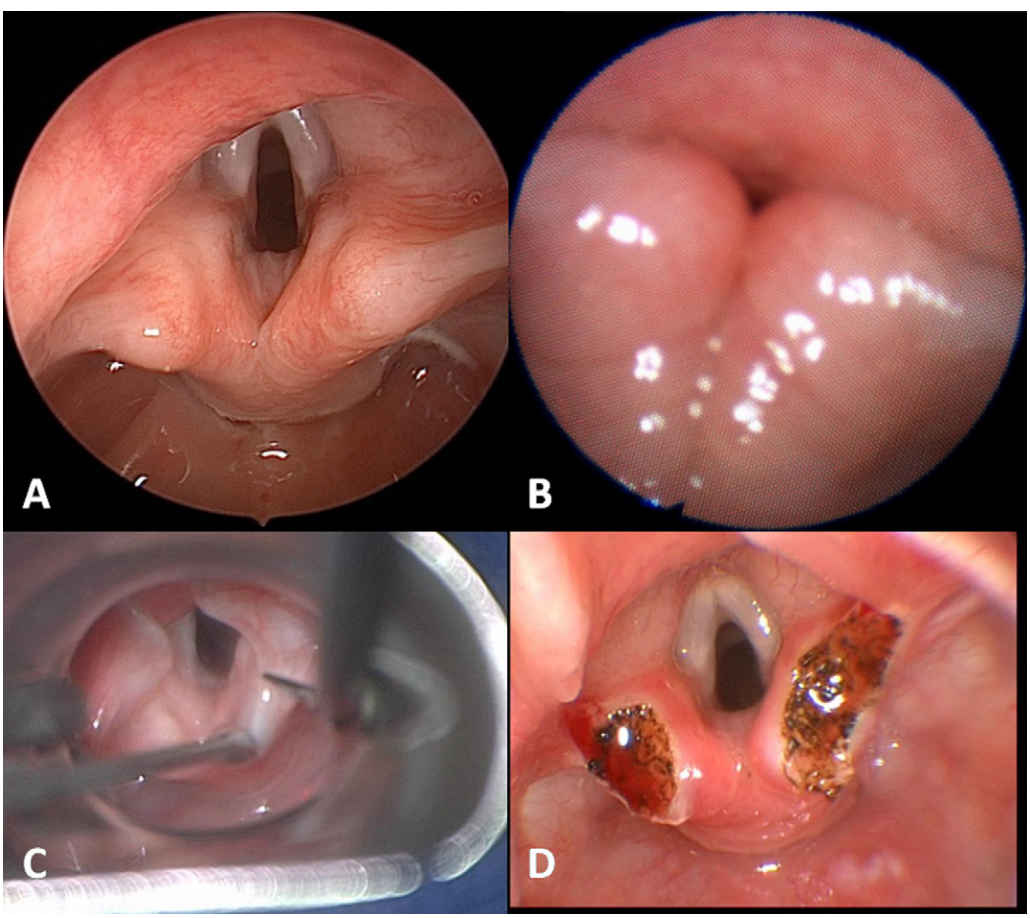

Fig. 1. (A) Normal position of supraglottic structures during expiration. (B) Collapse of arytenoids during inspiration. (C) Incising the aryepiglottic fold prior to laser excision of arytenoid mucosa and cuneiform cartilage. (D) After laser supraglottoplasty.