International Journal of Pediatric Otorhinolaryngology 78 (2014) 1158–1162

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

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

Beyond adenotonsillectomy: Outcomes of sleep endoscopy-directed treatments in pediatric obstructive sleep apnea

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ARTICLE INFO

Article history:
Received 1 December 2013
Received in revised form 10 March 2014
Accepted 20 April 2014
Available online 2 May 2014

Keywords:
Sleep endoscopy
MRI
Apnea
Obstructive sleep apnea
Pediatric sleep
Tonsillectomy

ABSTRACT

Objectives: In this study we determine the subjective and objective outcomes of pediatric patients with refractory OSA undergoing drug-induced sleep endoscopy (DISE)-directed surgical treatment.
Methods: 31 consecutive children with OSA following TA underwent DISE. 26 completed DISE-directed operative management of the level(s) of ongoing upper airway obstruction. Pre- and postoperative OSA were assessed through a detailed history (of nighttime symptoms (NS) and daytime symptoms (DS)), physical examination, and polysomnography.
Results: Age ranged 5–18 years (mean 9.7 ± 3.4). Fourteen of 26 had trisomy 21 (51%). Operations were performed in the following frequencies: lingual tonsillectomy (LT) (22), midline posterior glossectomy (MPG) (16), revision adenoidectomy (11), inferior turbinate submucosal resection (7), uvulopalatoplasty (2), and supraglottoplasty (2). Overall, 92% reported subjective improvement. NS improved from 5.8 ± 2.9 preoperatively to 2.1 ± 2.5 postoperatively ($p < 0.05$), while DS improved from 2.1 ± 1.3 preoperatively to 0.6 ± 1.1 postoperatively ($p < 0.05$). Seventeen patients completed preoperative polysomnography, while only 11 of them also completed postoperative polysomnography. Mean OAHI fell from 7.0 (±5.8) events/hr to 3.6 (±1.8) events/hr (*t*-test, $p = 0.09$).
Conclusions: Individualized, multilevel, DISE-directed operative therapy was associated with substantial improvement in subjective measures of sleep.

1. Introduction

Obstructive sleep apnea (OSA) occurs in 1–10% of children [1,2], and the effects of untreated OSA range from cardiopulmonary dysfunction to neurocognitive delay and learning disabilities in the classroom [3]. Adenotonsillectomy is the first-line therapy for most children with OSA, with a wealth of data indicating a positive response [4]. Indeed, most patients with an abnormal sleep study based on the obstructive apnea-hypopnea index (OAHI) improve with adenotonsillectomy regardless of the size of the tonsils or the severity of the sleep symptoms reported by the guardians [5,6].

In contrast, for the children who fail to improve or have a substantial remission of their OSA after adenotonsillectomy based on postoperative polysomnography, the treatment recommendations reported in the literature are highly disparate. Continuous positive airway pressure (CPAP) ventilation, multilevel operations in the pharynx, craniofacial framework surgery, and tracheotomy are all described, depending on the level(s) of ongoing collapse and other patient factors [7,8]. Some sense of the level(s) of collapse causing ongoing OSA can be diagnosed through a careful history and physical examination, including in-office endoscopic evaluation. However, sleep imaging and drug-induced sleep endoscopy (DISE) provide a more anatomically comprehensive and physiologic view of the entire upper airway during sleep [9,10], and they are well tolerated by the pediatric patient.

Families of children with refractory OSA were offered sleep medicine consultation to consider CPAP and other nonsurgical therapies (montelukast, nasal steroids, and antihistamines in patients with upper airway obstruction worsened by atopic disease). Those who were unwilling to initiate CPAP or unsuccessful with CPAP or medical management were offered DISE and directed therapies. To delineate the level(s) of ongoing airway

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http://dx.doi.org/10.1016/j.ijporl.2014.04.041
0165-5876/

obstruction, we performed DISE in 26 consecutive children with persistent obstructive sleep apnea after adenotonsillectomy. Using DISE-directed multi-level operations to correct persistent OSA, a majority of patients achieved improvement in their OSA.

2. Methods

Vanderbilt IRB approval was obtained to review the electronic medical records, and the following data were extracted: date of operation, type of operation, pre- and postoperative clinical symptoms, pre- and postoperative body mass index (BMI), pre- and postoperative polysomnographic (PSG) data, overall sense of improvement, medical comorbidities, and basic demographical data. Statistical analysis was performed on standard spreadsheet software.

The technique of manual bolus drug-induced sleep endoscopy has been described elsewhere [11]. After temporarily mask-ventilating the patient under sevoflurane/nitrous oxide inhalational anesthetic to secure peripheral intravenous access, our anesthesiologists used propofol (1 mg/kg boluses throughout the DISE to maintain the appropriate plane) to achieve an "asleep but spontaneously breathing" state that mimicked natural supine sleep. Due to cost concerns for such a short procedure, a bispectral analysis monitor (BIS) was not employed. The flexible endoscope was then passed from the naris to the larynx on both sides without any topical premedication of the nasal, oral, or oropharyngeal passageways. A careful assessment was made of fixed obstructions (septal, turbinate, adenoid, and lingual tonsillar-based obstructions) as well as dynamic obstructions that were accentuated under a spontaneously breathing plane of anesthesia due to Bernoulli forces in the airway. Dynamic obstructions included posterior displacement of the palate seen on inspiration, glossoptosis, which may exist in isolation or exacerbate lingual tonsillar hypertrophy, and collapse of the supraglottic larynx. Static and dynamic obstructions that filled or nearly filled the airway at that level were deemed significant and were targeted for therapy. While the VOTE (Velum, Oropharynx/lateral walls, Tongue base, Epiglottis) classification system [12] was not specifically employed due to our study period predating that assessment scheme, similar observations were made. That is, DISE might find no obstruction, partial obstruction with airflow limitation, or complete obstruction with apnea. Partially obstructive lesions that vibrated and produced audible airflow reduction (a VOTE grade 1 obstruction) and fully obstructive lesions (a VOTE grade 2 obstruction) were deemed targets for surgical therapy. Both the DISE and the subsequent operations to correct levels of airflow obstruction were performed under the same anesthetic, and we counseled patients *a priori* about the risks and benefits of the definite procedure (DISE itself) and the possible procedures DISE might recommend.

Therefore, levels of obstruction selected for operative intervention included nasal, nasopharyngeal, retropalatal, retrolingual, and supraglottic. Specifically, inferior nasal turbinates were reduced using a turbinate reduction blade affixed to a microdebrider (Medtronic, Minneapolis, MN). Following submucosal reduction, the turbinates were outfractured. Nasopharyngeal surgery consisted of revision adenoidectomy using a suction monopolar cautery. The retropalatal airspace was improved via a diamond-shaped excision of the oral mucosa of the uvula and posterior soft palate with anterior rotation and suturing of the residual uvula onto the margin of the palatal incision.

The retrolingual airspace was improved using lingual tonsillectomy (LT) and/or midline posterior glossectomy (MPG). A lingual tonsillectomy alone was performed if the patient had exophytic lingual tonsillar tissue and no additional glossoptosis or relative macroglossia that produced residual retrolingual airspace collapse after the LT. Likewise, MPG alone was performed when glossoptosis and/or macroglossia partially or fully obstructed the retrolingual airspace in the setting of nominal lingual tonsil tissue. When both large lingual tonsils and glossoptosis/relative macroglossia were present simultaneously, both operations were performed. Lingual tonsillectomy was performed using a Coblator Evac70 wand (ArthroCare, Austin, TX) on settings of 7 ablate and 3 coagulate to contour the hypertrophic lingual tonsillar tissue. Midline posterior glossectomy was performed after a Doppler device was used to isolate and mark the lingual arteries. A midline incision was made with monopolar cautery starting approximately 2 cm anterior to the circumvallate papilla and continuing posteriorly towards the vallecula. The wound was distracted open with retraction sutures, while a Coblation wand was used to remove tongue muscle submucosally between the boundaries of the lingual arteries and 1–1.5 cm deep into the tongue. The midline wound was primarily closed at the end with interrupted absorbable sutures. At the level of the larynx, significant supraglottic collapse was treated with a supraglottoplasty, using microlaryngeal scissors to release aryepiglottic folds and excise bulky supra-arytenoid tissue.

Table 1
Daytime and nighttime symptoms assessed during pre- and postoperative clinic visits. The clinical weight assigned to each symptom is given in points (pts).

	Weighted value (pts)
Daytime symptoms	
Daytime somnolence/intrusive naps	2
Mouth-breathing	2
Hyperactivity/attention deficit	1
Learning difficulty	1
Headache	1
Growth failure	1
Total possible	**8**
Nighttime symptoms	
Snoring	1
Gasping	2
Pausing	3
Fitful sleep	1
Sleep walking	1
Talking/moaning in one's sleep	1
Enuresis	2
Difficult arousal in the morning	1
Total possible	**12**

A clinical index was created prior to data compilation and analysis to describe daytime and nighttime symptoms related to sleep-disordered breathing as observed by the patients' guardians based on standard questions asked during each clinical encounter (Table 1). These symptoms were assigned point values. Specifically, for the nighttime symptoms, pausing (3 points) was deemed worse than gasping (a partial airflow obstruction worth 2 points), which was worse than simple snoring (worth 1 point). Because enuresis has been associated with OSA independent of obesity [13], the occurrence of secondary enuresis was given 2 points, while the remaining parasomnias received one point. Concerning the daytime symptoms, mouth-breathing and intrusive naps have been shown to be associated with OSA with a higher specificity than other daytime symptoms [14], and these were given a greater weight. The same questions were asked pre- and postoperatively to each patient's guardian, and the change in symptom severity was assessed by comparing the change in points.

3. Results

Thirty-one patients underwent DISE for OSA refractory to or recurrent after adenotonsillectomy. After hearing the risks, benefits, and alternatives to multilevel sleep operations 5/31 families elected to undergo DISE only to assess what levels of