Age-Related Outcomes of Sleep Apnea Surgery in Infants and Children

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This study was designed to determine whether age at the time of surgery is an important influencing factor on outcomes following surgical correction of severe refractory obstructive sleep apnea (OSA) in infants and children. Data were collected prospectively on 55 children, all with severe OSA refractory to conservative medical and surgical measures, who underwent combinations of soft-tissue and skeletal procedures aimed at relieving their airway obstruction. The study population was subdivided for analysis into three groups based on age at the time of surgery (>36 months, >12 to <36 months, and ≤12 months). Each child was assessed for clinical outcomes, polysomnography results, and complications. Children in the >36 months group demonstrated a significant improvement in respiratory disturbance index (RDI), apnea index, and lowest overnight oxygen saturation postoperatively. Only RDI improved significantly in the >12 to <36 months group. Although there was a trend toward improvement in the respiratory indices for the children ≤12 months of age, they had a significantly longer intensive care and hospital stay, a greater mean number of extubation attempts, and the highest surgical failure rate (29%). Other complications such as infection, atelectasis, or temporary postoperative nasopharyngeal tube dependence occurred most frequently in the >36 months group. Surgical management of severe refractory OSA in children age ≤12 months is more difficult and less likely to succeed. The reasons for this are discussed and recommendations for management are given.

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The sequelae of untreated upper airway obstruction in children are protean, including failure to thrive, pulmonary disease, neurological impairment and intellectual delay, cardiac failure, and death [1, 2]. Hitherto failure of conservative therapies has often necessitated tracheostomy placement with the attendant risks of tube dislodgment or obstruction leading to death, or late complications and decannulation difficulties relating to chronic infection or granulation tissue formation [3, 4]. Tracheostomy may have a profound negative impact on the child's social and psychological development, and in the long term imposes a financial burden on the parents. A variety of other surgical maneuvers have been employed to treat obstructive sleep apnea (OSA) with mixed results [5–8]. These have included soft-tissue procedures such as choanal dilatation and stenting, tonsillectomy, adenoidectomy, uvulopalatopharyngoplasty (UPP), palatal split, tongue-lip adhesion, and tongue reduction; or skeletal surgeries such as maxillary and monobloc advancements, all aimed at improving airway patency.

The senior authors have developed a treatment philosophy for refractory sleep apnea and for tracheostomy-dependent children with craniofacial deformities that has been reported elsewhere [9]. The approach is based on a multidisciplinary team evaluation to define the problem in terms of the anatomic and functional airway zones affected. From these data a rational, sequential, and case-directed surgical strategy is applied with the aims of improving the respiratory index, avoiding tracheostomy, and preventing the long-term sequelae. This protocol has been applied across all age groups for a variety of underlying conditions. It has been our clinical impression that in the younger children (<12 months) it has been more difficult to achieve our aims. This study was undertaken to determine whether the age at time of surgery is an important influencing factor on outcomes of sleep apnea surgery in children and, if so, the reasons for any observed differences.

Patients and Method

Fifty-five children were treated surgically between July 1989 and December 1995. There were 35 males and 20 females, and age at time of surgery ranged from 2 to 221 months (mean, 67.8 months). To analyze the impact of age at surgery, the patient population was subdivided into three groups: those older than 36 months, those between 12 and 36 months, and those age 12 months or younger at the time of surgery. Data were collected prospectively for each case and the mean follow-up for the group was 21 months (range, 1–70 months).

All children presented with severe OSA refractory to medical management. Medical failure for each of the three age groups was defined as: (1) persistent upper airway obstruction in spite of supplemental oxygen, CPAP, and tonsillectomy and adenoidectomy if indicated; (2) inability to tolerate CPAP; and (3) ventilator- or tracheostomy-dependent patients with upper airway obstruction who failed conventional weaning and decannulation procedures. Four of the patients already had tracheostomies, which had been placed shortly after birth to relieve airway obstruction. Surgical treatment was aimed at relief of the upper airway obstruction to improve symptoms and respiratory indices, and to avoid either long-term tracheostomy or permit tracheostomy decannulation. Clinical evaluation was carried out in each patient by the craniofacial surgery team and a pediatric pulmonologist. This included a complete history, physical examination, chest and cervical spine radiographs, a lateral cephalogram, computerized axial tomography (CAT) scan of the head and neck, a 12-lead electrocardiogram, cardiac ultrasonography, investigation for gastroesophageal reflux, and, when indicated, flexible endoscopy of the upper airway during spontaneous ventilation. In addition, overnight 12-channel polysomnography (PSG) was recorded before and after surgery, when possible. These sleep data, which included oxygen saturation recordings, allowed calculation of the apnea index (AI; the number of apneic events divided by total sleep time in minutes and multiplied by 60) and the respiratory disturbance index (RDI; the number of apneas *and* hypopneas divided by total sleep time and multiplied by 60).

Based on these data, sleep apnea surgery consisting of various combinations of soft-tissue reduction and skeletal expansion procedures [9, 10] was recommended. The nasal airway was inspected and all sites of obstruction were evaluated. Treatment was directed at septal deviation, turbinate hypertrophy, choanal stenosis, and adenoidal hypertrophy if present. Horizontal, vertical, and transverse nasal dimensions were analyzed to determine if inferior maxillary repositioning and/or transverse palatal expansion by a Le Fort or segmental Le Fort osteotomy was indicated. The soft palate and lateral pharyngeal walls were inspected. If the soft palate was touching or close to the pharynx, or enlarged tonsils were present, UPP and/or tonsillectomy were carried out. The size and position of the tongue were also evaluated. Central tongue reduction (using a carbon dioxide laser) was indicated for macroglossia, which was present in several of the Down syndrome patients and a few of the patients with cerebral palsy. Sagittal advancement of the tongue away from the retropharyngeal wall was accomplished by mandibular advancement and/or genioplasty with a tongue-hyoid suspension. In order to treat the infant and younger child, a variety of modifications to existing surgical techniques were made, and are discussed later. The operative procedures that were used have been broadly grouped into either "skeletal surgery" or "soft-tissue surgery" and further subdivided according to age at time of surgery (Tables 1 and 2).

All 55 patients were included in comparing complication rates among the three age groups. The analyses of changes in PSG results were restricted to patients with both pre- and postoperative PSG data. Of the 32 patients whose age at surgery was >36 months, 28 (88%) had complete data for RDI and low oxygen saturation (LO_2S), and 29 (91%) had complete data for AI. Of the 16 patients whose age at surgery was >12 to <36 months, 8 (50%) had complete data for the three PSG variables. Of the 7 patients whose age at surgery was <12 months, 3 (43%) had complete data for the three PSG variables. The reason for data variability is that some of the children were intubated, in severe respiratory distress, or had tracheostomies prior to sleep apnea surgery and therefore PSG could not be obtained.