



## Nasal and palatal surgery for obstructive sleep apnea syndrome

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Sleep disordered breathing is common. In the mildest form, it manifests as snoring which is often considered a cosmetic complaint. Sleep-related breathing disturbances increase in severity to include the upper airway resistance syndrome and obstructive sleep apnea syndrome (OSAS) which result in daytime sleepiness, and have established medical morbidity and mortality risks. Overt OSAS affects an estimated 4% of men and 2% of women [1]. Because of its significant social, functional, and medical morbidity, OSAS frequently presents for treatment. Nasal continuous positive airway pressure (nasal CPAP) has become the preferred initial treatment for most patients; when this or other conservative treatments fail, however, surgery may be offered. Surgery may bypass the upper airway obstruction or may reconstruct the upper airway using either skeletal or soft tissue techniques. It is commonly accepted that airway obstruction in OSAS is complex and, in most patients, multiple levels of the pharynx contribute to collapse, obstruction, and increased airway resistance [2,3]. Surgical goals are to increase airway size, decrease airway collapsibility, decrease airway resistance and the work of breathing, and reduce partial and complete airway obstructions (apnea and hypopnea). Improved ventilation reduces sleep and medical manifestations of OSAS. Nasal and palatal surgeries may contribute to these goals and are part of the surgical treatment armamentarium for OSAS. Although in some patients, nasal and palatal surgeries may be used in isolation,

for many patients these procedures are only a portion of the treatment. Palatal and nasal surgeries are more often used in isolation for the treatment of snoring of palatal etiology [4]. Primary snoring is a common and significant presenting complaint, and a concern of many patients. This chapter addresses specific surgical procedures that may treat upper pharyngeal and palatal airway obstruction.

### Algorithms for treatment

A variety of surgical algorithms have been described to treat both snoring and OSAS. Historically, surgery on the nose, upper pharynx, and palate were considered to treat OSAS. Fujita proposed uvulopalatopharyngoplasty (UPPP) as the first specific reconstructive procedure for OSAS [5]. UPPP was a modification of palatopharyngoplasty proposed by Ikamatsu for snoring prior to the recognition of OSAS [6]. Prior to this description, tonsillectomy and nasal surgery were proposed as treatments with limited success in most patients. Uvulopalatoplasty was described by Kamami for the treatment of snoring [7]. Laser-assisted uvula-palatoplasty (LAUP) has multiple modifications and subsequently was applied to the treatment of OSAS [8]. Aggressive UPPP or alternative UPPP techniques have also been described [9].

Two different approaches have been used to improve success of limited pharyngeal surgeries for OSAS. The first approach is to improve patient selection with the goal of eliminating patients at high risk of failure [10]. Patients conceivably at high risk of failure may be those with severe disease, marked obesity, neurologic abnormalities, and sites of obstruction not

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confined to the nose and palate. The second approach has been to combine palatal surgeries with nasal surgery and tongue base surgery to address multiple sites or more severe obstruction better [11]. Both approaches have modestly improved success rates [12]. Although success is not ideal and requires improvement, such an approach often balances the severity of the disorder, improved clinical outcomes, and acceptance by the patient unwilling to proceed with more aggressive and more successful approaches such as maxillo-mandibular surgery or tracheotomy.

It is widely accepted that upper airway collapse in OSAS occurs in the soft tissue supra-laryngeal pharynx [13]. The site of obstruction varies both between patients and even in the same patient depending on sleep state and body position. Various methods using endoscopy, manometry, and airway imaging have attempted to define the location of pathology. Nasal obstruction has been associated with complaints of poor sleep, snoring, and OSAS [14–16]. Nasal airflow has been shown to stimulate ventilation during sleep [17].

## Surgical treatment

### *Nasal*

Treatment of nasal obstruction varies according to pathology. Septal deviation, inferior turbinate hypertrophy, nasal valve collapse, and nasal polyps are common causes of nasal obstruction. In sleep apnea as well as other disorders with abnormal facial structure, increased nasal resistance may reflect abnormal maxillary morphology [18]. Although nasal airway resistance does not alter static measures of pharyngeal pressure when applying nasal CPAP, nasal obstruction may impair the clinical acceptance of CPAP [19]. Surgical treatment of obstruction may decrease clinically effective nasal CPAP pressures and theoretically improve compliance and acceptance [20]. Treatment of nasal obstruction improves daytime and nighttime subjective quality of life, sleep, and daytime performance. Although successful surgical treatment of the nose may alleviate symptoms, surgery alone offers a low likelihood of definitive OSAS treatment. Nasal surgery, however, may be definitive in selected patients. In a study using lateral cephalometric X rays to define upper airway abnormalities, Series found those patients likely to benefit most had mild OSAS, dramatic obstruction, and no other upper airway pathologies [21].

Nasal procedures may include septoplasty, turbinate reduction, nasal valve surgeries, or sinus sur-

gery. Techniques and procedures will vary on the pathology present. Under limited circumstances, nasal surgery may be simultaneously performed with other pharyngeal surgeries. Controversy exists as to the safety of performing simultaneous nasal and other pharyngeal surgeries [22]. Which sleep apnea surgeries are safe to pursue combined with nasal surgery has not been established. Criteria to consider include but are not limited to: (1) mild OSAS, (2) no anticipated requirement of nasal packing that would preclude perioperative nasal CPAP, (3) no major medical comorbidity that will place the patient at risk, and (4) appropriate and skilled postoperative monitoring and observation.

### *Tonsillectomy*

Tonsil hypertrophy is a common contributor to OSAS in children; however, in adults, it is uncommon. It is commonly accepted that tonsillectomy alone is not definitive for most adults with OSAS. But when tonsillar hypertrophy is present, surgical treatment may be definitive. Verse et al reported an 80–100% success rate in adults treated for marked tonsil hypertrophy [23]. Tonsillar hypertrophy treated simultaneously with UPPP also demonstrates higher success rates [24]. Some authors have suggested that, when performed with tonsillectomy, UPPP has higher success rates [25]. Reviews by Sher et al have not been able to confirm this hypothesis [12].

### *Uvulopalatopharyngoplasty*

UPPP was initially described by Fujita [5]. For many, the concept of “surgery for OSA” is UPPP. Many have subsequently modified UPPP; all methods have in common a reconstructive operation to enlarge the pharynx for treating OSAS. This is in contrast with other techniques of palatopharyngoplasty that are directed at narrowing or closing the incompetent pharynx such as with cleft palate or velopharyngeal incompetence. Fujita’s initial operation involved partial modification of the uvula, removal of redundant pharyngeal and palatal tissues, and primary closure of the posterior and anterior pillars to enlarge the retropalatal airway. Other modifications have involved complete removal of the uvula and distal soft palate, removal of portion of the palatopharyngeus muscle [26], and an uvulopalatal flap [27].

Historically, UPPP offered the first viable alternative to tracheotomy; however, for many patients UPPP alone was at best partially effective. Although major complications are uncommon, minor complica-

tions and side effects are not infrequent [28]. Meta-analysis by Sher et al observed that in nonselected patients short-term success was 40.2%. This success decreased to 5% when tongue base obstruction was identified. Multiple authors have attempted to improve UPPP success by improving patient selection. Success has been variable, yet some techniques have been promising. Isono et al using an objective endoscopic method have demonstrated higher success rates [29]. Manometry during sleep has also demonstrated high success rates [30]. Wide applicability is lacking to corroborate these results. UPPP data is difficult to interpret because of incomplete follow-up, lack of standardized outcomes, and few controlled or randomized studies [31]. Such deficiencies, however, are not unique in the surgical literature as a whole. Important outcomes following surgery include survival, sleepiness, performance, snoring, complications, and long-term results.

Overall data with UPPP is consistent with a positive clinical effectiveness. Studies indicate that survival with UPPP is not worse than with nasal CPAP [32]. Sleepiness using multiple sleep latency testing is equal to compliant CPAP patients [33]. Driving performance is improved over both the short and long term [34]. Short-term snoring improvement occurs [35]. Studies have also demonstrated long-term improvement without worsening of OSAS. Concern about UPPP and subsequent CPAP failure has been presented [36]. Increased mouth leaks after palatal shortening is a potential complication, however; its true incidence is unknown. In some patients, removal of pharyngeal redundancy may improve CPAP compliance and effectiveness. Further study is needed.

Few prospective randomized studies exist. Studies comparing UPPP with conservative treatments show marked improvements in sleep and quality of life [37]. Final quality of life outcomes were similar to nasal CPAP in compliant patients. Objective respiratory outcomes demonstrated significant improvements, although final outcomes were less than in laboratory success of nasal CPAP. Randomized against oral appliances, UPPP demonstrated better or equivalent outcomes [38].

#### *Laser-Assisted Uvulopalatoplasty*

LAUP was initially described by Kamami for snoring and subsequently applied to treat OSAS. LAUP results have been controversial with strong proponents and opponents. Limited data exists to determine effectiveness for the treatment of OSAS. Several laser techniques have been described. Initially, LAUP was performed as a serial procedure over many

sessions. Palatal trenches were created parallel to the uvula into the soft palate. The uvula was then shortened, and the wound allowed to heal by secondary intention. Subsequent modifications involved more aggressive resection of the soft palate and posterior tonsillar pillars [39]. Single stage LAUP has also been described [40]; other modifications include removal of palatal and uvular mucosa and uvula shortening [41]. These palatal stripping procedures have subsequently been described as using electrocautery (cautery assisted palatal stripping) and injection snoreplasty [42]. In the latter procedure, mucosa is ablated using sclerotherapy agents injected into the submucosa.

Objective evaluation of LAUP is difficult. Few studies use objective respiratory data. Subjective outcomes are often nonstandardized and primarily relate to snoring as a primary outcome. Most studies report a marked improvement in snoring. Short-term success rates of 70% or greater have been reported. Some decrement over time is likely. Effects on OSAS are more controversial. Some reports suggest a 30–40% success rate [43]. Other reports raise concern about airway stenosis or potential worsening of OSAS [44,45]. Outcomes may likely differ according to surgical technique used and the surgical patient population. Further objective evaluation is required.

#### *Radiofrequency*

Radiofrequency tissue ablation with or without temperature control has been described for treatment of both snoring and OSAS. These are discussed in other articles.

#### *Transpalatal advancement*

A novel approach to palatopharyngoplasty is the transpalatal advancement approach [46]. This modification increases oropharyngeal size not only by reducing distal pharyngeal redundancy but by palatal advancement. Separating the soft and hard palate and excising distal palatine bone provide advancement. The soft plate is mobilized and advanced into the defect. Compared with UPPP, significant increases in cross-sectional area and decreases in pharyngeal collapsibility are observed [47]. In small series, significant improvement in OSAS is observed.

#### **Summary**

Significant abnormalities of the nose and upper pharynx contribute to OSAS and primary snoring. Surgical correction may significantly improve these

disorders. Although when used alone, nasal surgery is only partially successful, it is an important component in the surgical armamentarium. Improvements in methods and surgical selection of palatal surgery are needed. Considering that the upper pharynx is the airway segment most vulnerable to closure, improving the surgical approach to this area likely will increase surgical success.

## References

- [1] Young T, Palta M, Dempsey J, et al. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med* 1993;328(17):1230–5.
- [2] Katsantonis GP, Moss K, Miyazaki S, et al. Determining the site of airway collapse in obstructive sleep apnea with airway pressure monitoring. *Laryngoscope* 1993;103(10):1126–31.
- [3] Morrison DL, Launois SH, Isono S, et al. Pharyngeal narrowing and closing pressures in patients with obstructive sleep apnea. *Am Rev Respir Dis* 1993;148:606–11.
- [4] Liistro G, Stanescu D, Veriter C, et al. Pattern of snoring in obstructive sleep apnea patients and heavy snorers. *Sleep* 1991;14:517–25.
- [5] Fujita S, Conway W, Zorick F, et al. Surgical correction of anatomic abnormalities of obstructive sleep apnea syndrome: uvulopalatopharyngoplasty. *Otolaryngol Head Neck Surg* 1981;89:923–34.
- [6] Ikamatsu T. Palatopharyngoplasty and partial uvulotomy method of Ikamatsu: a 30 year clinical study of snoring. In: Fairbanks D, Fujita S, Ikamatsu T, Simmons FB, editors. *Snoring and Sleep Apnea*, ed 1. New York: Rivlin Press; 1987. p. 130–34.
- [7] Kamami Y. Outpatient treatment of snoring with CO2 laser: laser-assisted UPPP. *J Otolaryngol* 1994;23(6):391–4.
- [8] Krespi Y, Pearlman S, Keidar A. Laser-assisted uvulopalatoplasty for snoring. *J Otolaryngol* 1994;23(5):328–34.
- [9] Zohar FY, Strauss M, et al. Surgical treatment of obstructive sleep apnea: comparison of techniques. *Arch Otolaryngol Head Neck Surg* 1993;119:1023–9.
- [10] Sher AE, Thorpy MJ, Shprintzen RJ, et al. Predictive value of Muller maneuver in selection of patients for uvulopalatopharyngoplasty. *Laryngoscope* 1985;95:1483–7.
- [11] Riley RW, Powell NB, Guilleminault C. Obstructive sleep apnea syndrome: a review of 306 consecutively treated surgical patients. *Otolaryngol Head Neck Surg* 1993;108:117–25.
- [12] Sher AE, Schechtman KB, Piccirillo JF. The efficacy of surgical modifications for the upper airway in adults with obstructive sleep apnea syndrome. *Sleep* 1996;19:156–77.
- [13] Shepard JW, Thawley SE. Localization of upper airway collapse during sleep in patients with obstructive sleep apnea. *Am Rev Respir Dis* 1990;141:1350–5.
- [14] Loth S, Petruson B, Wiren L, Wilhelmson L. Better quality of life when nasal breathing of snoring men is improved at night. *Arch. Otolaryngol. Head Neck Surg.* 1999;125:64–7.
- [15] Young T, Finn L, Kim H. Nasal obstruction as a risk factor for sleep-disordered breathing. *Allergy Clin Immunol* 1997;99:s757–62.
- [16] Lofaso F, Coste A, d'Ortho MP, Zerah-Lancner F, Delclaux C, Gooldenber F, et al. Nasal obstruction as a risk factor for sleep apnoea syndrome. *Eur Respir J* 2000;16:639–43.
- [17] McNichols WT, Coffey M, Boyle T. Effects of nasal airflow on breathing during sleep in normal humans. *Am Rev Respir Dis* 1993;147:620–3.
- [18] Cistulli PA, Sullivan CE. Influence of maxillary morphology on nasal airway resistance in Marfan's syndrome. *Acta Otolaryngol* 2000;120:410–3.
- [19] Schechter GL, Ware C, Perlstrom J, McBrayer RH. Nasal patency and the effectiveness of nasal continuous positive air pressure in obstructive sleep apnea. *Arch Otolaryngol Head Neck Surg* 1998;118:643–7.
- [20] Friedman M, Tanyeri H, Lim JW, Landsberg R, Vaidyanathan K, Caldarelli D, et al. Effect of improved nasal breathing on obstructive sleep apnea. *Arch Otolaryngol Head Neck Surg* 2000;122:71–4.
- [21] Series F, St Pierre S, Carrier G. Surgical correction of nasal obstruction in the treatment of mild sleep apnoea: importance of cephalometry in predicting outcome. *Thorax* 1993;48:360–3.
- [22] Fairbanks DNF. Uvulopalatopharyngoplasty complications and avoidance strategies. *Arch Otolaryngol Head Neck Surg* 1990;102:239–45.
- [23] Verse T, Kroker B, Pirsig W, et al. Tonsillectomy as a treatment of obstructive sleep apnea in adults with tonsillar hypertrophy. *Laryngoscope* 2000;110:1556–9.
- [24] Houghton DJ, Camilleri AE, Stone P. Adult obstructive sleep apnea syndrome and tonsillectomy. *J Laryngol Otol* 1997;111:829–32.
- [25] McGuirt WF, Johnson JT, Sanders MA. Previous tonsillectomy as prognostic indicator for success of uvulopalatopharyngoplasty. *Laryngoscope* 1995;105:1253–5.
- [26] O'Leary MJ, Millman RP. Technical modification of uvulopalatopharyngoplasty: the role of the palatopharyngeus. *Laryngoscope* 1991;101:1332–5.
- [27] Powell N, Riley R, Guilleminault C, Troell R. A reversible uvulopalatal flap for snoring and sleep apnea syndrome. *Sleep* 1996;19:593–9.
- [28] Haavisto L, Suonpaa J. Complications of uvulopalatopharyngoplasty. *Clin Otolaryngol* 1994;19:243–7.
- [29] Isono S, Akiko S, Tanaka A, et al. Efficacy of endoscopic static pressure/area assessment of the passive pharynx in predicting uvulopalatopharyngoplasty outcomes. *Laryngoscope* 1999;109:769–74.
- [30] Skatvedt O, Akre H, Godtliebsen OB. Continuous pressure measurements in the evaluation of patients for

- laser assisted uvulopalatoplasty. *Eur Arch Otorhinolaryngol* 1996; 253.
- [31] Schechtman KB, Sher AE, Piccirillo JF. Methodological and statistical problems in sleep apnea research: the literature on uvulopalatopharyngoplasty. *Sleep* 1995; 18:659–66.
- [32] Keenan SP, Burt H, Ryan F, Fleetham JA. Long-term survival of patients with obstructive sleep apnea treated by uvulopalatopharyngoplasty or nasal CPAP. *Chest* 1994;105:155–9.
- [33] Zorick FJ, Roehrs T, Conway W, et al. Response to CPAP and UPPP in apnea. *Henry Ford Hosp Med J* 1990;38:223–6.
- [34] Haraldsson P, Carefelt C, Lysdahl M, et al. Long-term effect of uvulopalatopharyngoplasty on driving performance. *Arch Otolaryngol Head Neck Surg* 1995; 121:90–4.
- [35] Friberg D, Carlsson-Nordlander B, Larsson H, et al. UPPP for habitual snoring: a 5-year follow-up with respiratory sleep recordings. *Laryngoscope* 1995;105: 519–22.
- [36] Mortimore IL, Bradley PA, Douglas NJ. Uvulopalatopharyngoplasty may compromise nasal CPAP therapy in sleep apnea syndrome. *Am J Respir Crit Care Med* 1996;154:1759–62.
- [37] Lojander J, Maasilta P, Partinen M, Brander P, Salmi T, Lehtonen H. Nasal-CPAP, surgery, and conservative management for treatment of obstructive sleep apnea syndrome. *Chest* 1996;110:114–9.
- [38] Wilhelmsson B, Tegelberg A, Walker-Engstrom M, Ringqvist M, Andersson L, Krekmanov L, et al. A prospective randomized study of a dental appliance compared with uvulopalatopharyngoplasty in the treatment of obstructive sleep apnea. *Acta Otolaryngol* 1999;119:503–9.
- [39] Krespi Y, Pearlman S, Keidar A. Laser-assisted uvulopalatoplasty for snoring. *J Otolaryngol* 1994;23: 328–34.
- [40] Dickson R, Mintz D. One-stage laser-assisted uvulopalatoplasty. *J Otolaryngol* 1996;25:155–61.
- [41] Clarke R, Yardley M, Davies C, et al. Palatoplasty for snoring: a randomized controlled trial of three surgical methods. *Arch Otolaryngol Head Neck Surg* 1998; 119: 288–92.
- [42] Brietzke SE, Mair EA. Injection snoreplasty: how to treat snoring without all the pain and expense. *Arch Otolaryngol Head Neck Surg* 2001;12:503–10.
- [43] Walker R, Grigg-Damberger M, Gopalsami C. Laser-assisted uvulopalatoplasty for the treatment of mild, moderate, and severe obstructive sleep apnea. *Laryngoscope* 1999;109:79–85.
- [44] Finkelstein Y, Shapiro-Feinber M, Stein G, Ophir D. Uvulopalatopharyngoplasty vs laser-assisted uvulopalatoplasty. *Arch Otolaryngol Head Neck Surg* 1997; 123:265–76.
- [45] Ryan CF, Love LL. Unpredictable results of laser assisted uvulopalatoplasty in the treatment of obstructive sleep apnoea. *Thorax* 2000;55:399–404.
- [46] Woodson BT, Toohill RJ. Transpalatal advancement pharyngoplasty for obstructive sleep apnea. *Laryngoscope* 1993;103:269–76.
- [47] Woodson BT. Retropalatal airway characteristics in UPPP compared to transpalatal advancement pharyngoplasty. *Laryngoscope* 1997.