**MANAGEMENT OF SLEEP-DISORDERED BREATHING**
**June 29th 2013**

## Sleep Dentistry and Otolaryngology Head and Neck Surgery

**General Introduction:**

Sleep-disordered breathing (SDB) is a collective term which includes snoring, upper airway resistance syndrome (UARS) and obstructive sleep apnea syndrome (OSAS). Simply put, the term is descriptive of the effects of an anatomic partial collapse or obstruction of the upper airway during sleep which may cause sleep fragmentation.

Surgical management was the first treatment modality available for SDB. Some of the first subjects to undergo surgery for an anatomic narrowing or blockage of the upper airway during sleep were those afflicted with the Pickwickian Syndrome (obesity-hypoventilation syndrome). Tracheotomy was the sole surgical procedure available during this period and since it was lifesaving in these circumstances, tracheotomy was also used for others with nocturnal upper airway obstruction.[1] Morbidity and mortality were not established except for the very severely affected, and the tracheotomy was not well tolerated or accepted by most patients even as a method to improve the quality of life, or extend life itself.

In the early 70's the term used to describe nocturnal airway obstruction was hypersomnia with periodic apnea (HPA), later revised to be called obstructive sleep apnea syndrome (OSAS), and now better known collectively as Sleep-Disordered Breathing (SDB).

Over thirty years have passed and our knowledge of sleep disorders has evolved to such an extent that sleep disorders is now a recognized specialty in medicine and should be, in the future, a specialty in surgery. The coupling of medicine and surgery for the definitive management of SDB is necessary due to the fact that upper airway narrowing or blockage during sleep was thought to be an anatomic problem and thus the surgeon's domain.

In addition, not all patients will accept medical management as the primary first choice, and vice versa, the same holds true for surgical acceptance. Granted, there is surely a central nervous system (CNS) mediator associated with this syndrome that no one has been able to identify. However, medical management, the present treatment of choice, is now suffering with compliance problems and resistance from the younger subset of patients, who have debilitating daytime somnolence due to upper airway resistance syndrome (UARS), and do not want to wear a nasal device (CPAP/BiPAP) six to eight hours a night for the next forty or fifty years. Hence, between the two modalities we may offer alternatives as is appropriate.

What we have learned about the obstructive process in sleep disorders, with the imput of the combined efforts of our surgical and medical colleagues, is that nocturnal narrowing or

obstruction may be localized to one or two areas, or may encompass the entire upper airway passages to include the *nasal cavity*, *oropharynx* and *hypopharynx*. Conservative medical therapy is usually recommended first. Treatment centers on sleep hygiene, weight loss, dental splints and nocturnal nasal pressure devices (CPAP/BiPAP). There are surgical procedures presently available to provide for a logical upper airway reconstruction of this region.[2-3] This usually will encompass multiple surgical procedures or sites, in such a manner as to minimize risks and complications, and to subsequently relieve the patient of this problem. Current established surgical procedures offer reconstruction of the airway from the nose and palatal level to the tongue base.

***Rationale for Surgery:***

Nearly all patients with documented SDB are candidates for surgical intervention. This mandates that the patients are medically and psychologically stable and wish to undergo a surgical procedure. They should be informed of the various treatments both medical and surgical along with current treatment philosophies. Surgical indications should include the two major parameters of OSAS, the neurobehavioral and cardiopulmonary derangements caused by nocturnal obstructions during sleep.

Patients with UARS usually present with marked excessive daytime sleepiness (EDS). Since there are numerous other causes of EDS such as narcolepsy, insomnia and sleep deprivation, a nasal CPAP trial, in this group, can be diagnostic and therapeutic thus helping to establish that EDS is secondary to upper airway resistance and sleep fragmentation (SDB). The cardiopulmonary risks of OSAS have been documented when the apnea hypopnea index (AHI) is greater than 20 events per hour of sleep and a nadir oxygen saturation is below 90%.[4] This severity of disease necessitates treatment to lower the risk of cardiopulmonary sequela and the increased mortality rate.

***Specific Indications for Surgery:***

Excessive daytime sleepiness,(EDS) or with a AHI $\geq$ 20 events per hour of sleep, oxygen desaturation $\leq$ 90%, arrhythmias, negative esophageal pressures (Pes > -10 $cmH_20$) and failure of medical management or desire of patient to select treatment modality where appropriate. In patients with an AHI < 20 events per hour of sleep and associated excessive daytime somnolence that interferes with daily functioning, surgery is considered appropriate on a case by case basis. Our existing Stanford Protocol (Powell-Riley) is predicated on evidence based medicine for these treatments. Clinical outcomes for all existing surgical procedures are listed below under current surgical techniques and have been validated over time by other centers in the United States and Europe and Asia.

***Pre-Surgical Evaluation:***

A standard should include polysomnography, a comprehensive history with head and neck physical examination, fiberoptic nasopharyngoscopy and 3D-CT imaging analysis where

available. This will give sufficient data base information to help in directing surgical therapy and addressing the possibilities for treatment or clinical outcomes. It is recommended and cautioned that no one test or procedure is to be relied on to make such decisions. This systematic medical and surgical review will support the establishment of the following guidelines: *determine sleep disorder type, establish parameters of severity, identify comorbidity factors and probable sites of obstruction, decide if treatment is emergent or elective and assess the risks and benefit ratios.*

**Contemporary Surgical Techniques for SDB:**

Nasal reconstruction
Tracheotomy
Retropalate UPPP /Tonsils
Retrolingual Tongue advancement
Genioglossus Advancement-Hyoid (GAHM)
Bi-Maxillary Advancement (MMA/BMA)

**Current Surgical Techniques:**

***The Airway Bypass: Tracheotomy***

*Rationale:* Immediate resolution of obstructive breathing during sleep in most subjects.

*Indications:* Where an emergent airway is necessary or where there is neither the specialized equipment or surgical expertise to offer an alternative, morbid obesity (BMI $> 33$ kg/m$^2$), severe hypoxemia ($Sa0_2 \leq$ 70%) severe arrhythmia, asystole, PVC's, uncontrolled hypertension and where surgery to alleviate upper airway obstruction may compromise the airway secondary to edema or drug therapy and CPAP is not available or tolerated by the patient. In reality tracheotomy is usually, but not always, poorly tolerated or accepted. This is especially true now since nasal CPAP has been used so successfully for severe OSAS that tracheotomy has taken a second position in the treatment of OSAS.

*Techniques:* Temporary or permanent tracheotomy methods may be employed to maintain the airway.

*Clinical outcomes:* The tracheotomy should be considered a conservative modality of airway protection in severe OSAS and especially in those who are morbidly obese. It is considered a 100% cure in most instances.

***Nasal Obstruction: Reconstruction***

*Rational:* An open nasal airway establishes physiologic breathing and may minimize the use of the open oral airway. It should be remembered that when the mouth is open the lower jaw auto-rotates open and allows the tongue to fall back into the posterior airway space. In some

patients improvement of the nasal airway may also improve CPAP tolerance and /or compliance.

*Indications:* Nasal airway blockage caused by bony, cartilaginous or hypertrophied tissues that interfere with nasal breathing during sleep.

*Techniques:* Septal and /or bony intranasal reconstruction, alar valve or alar rim reconstruction, turbinectomy.

*Clinical outcomes:* The ease and high success rate of nasal reconstruction makes this procedure a very valuable technique for those with nasal obstruction and SDB. By itself it is not likely to make a significant impact on moderate or severe SDB as palatal or tongue base *surgery can.*

*However, it is still an essential part of the upper airway that should not be ignored* in the overall treatment of SDB. Correction of any defects at this level assures the ability for minimizing oral breathing and certainly should decrease the possibilities of elevated nasal negative pressure breathing during sleep.[5-9]

***Retropalatal Obstruction: Reconstruction***

*Rationale:* The palatal and lateral pharyngeal tissues have been found to be the most compliant of the upper airway and documentation of the collapse at this level in SDB is well established.

*Indication:* A long soft palate, narrow inlet to the nasopharynx, hypertrophic tonsils and redundant lateral pharyngeal mucosa. This level of obstruction is classified as a Fujita Type 1.

*Techniques:* There are multiple methods to control this region and range from the traditional UPPP first described in the United States by Doctor Fujita as well as the many variations of his original procedure. Surgical flaps, lasers, caurtery or radiofrequency have also been used.

*Clinical outcomes:* Individual results vary with the skill of the surgeon and the technique selected. The safe clearance of the tissue blockage at this level is essential to the improvement of SDB and the standard techniques are excellent in accomplishing this goal. The technique has not gained widespread popularity over the years due to the pain and discomfort after surgery and the fact that cure rate was so varied.[10] This was due, in part, to the fact that during the time that UPPP was first introduced there was not an appreciation for the possibility of tongue base obstruction. Many UPPP's did clear the pharyngeal level of obstruction and were unfairly credited with failure due to the unrecognized tongue base problem (hypopharyngeal). In patients who have been carefully selected for upper airway reconstruction and whose site of primary obstruction is at the oropharyngeal level (Fujita type 1) the cure rate may be 80 to 90 %.[11] In unselected patients this rate will fall to a low of 5 to 30%.[10]

Classification of Obstructive Region by S. Fujita
Type I Palate (normal tongue base)
Type II Palate and base of tongue
Type III Base of tongue (normal palate)

***Retrolingual Obstruction: Reconstruction***

*Rationale:* Tongue base obstruction has been documented in SDB by EMG studies, fiberoptic exams, radiographic cephalograms, CT, MRI scans and vidiofluoroscopy. In addition, the basic anatomy and physiology of the skeletal relationships and genioglossus-hyoid complex as it relates to airway size awake and asleep have led to a better understanding of how to surgically approach the base of tongue level (Fujita type 3).

*Indications:* Those of the general indications for surgery with findings of clinical tongue base obstruction.

*Techniques:* The obstruction of the hypopharyngeal (base of tongue) region is a very complex problem since there is a large mass of tongue tissue with varied elasticity during sleep, compared to the nasal and palatal levels, coupled with other accessory hypopharyngeal dilators that must be managed in order to successfully open this region during sleep. This region may be bypassed by tracheotomy or approached logically by either making more room for the tongue or reducing the tongue size. There are soft tissue techniques to remove the mid portion of the tongue base using laser midline glossectomy and lingualplasty [12], partial glossectomy [13] or volumetric shrinkage by radiofrequency.[14]

In addition, there are skeletal advancements that attempt to place tension on the tongue so during sleep the tongue may not fall as far back. This procedure is referred to as Phase one of the Powell-Riley phased protocol [15] (inferior sagittal mandibular osteotomy and genioglossus advancement, hyoid myotomy and suspension). This is a simple technique that does not move the teeth or jaw and therefore does not interfere with the dental bite.

A more aggressive procedure, usually saved for failure of the more conservative surgery above, is the forward movement of the lower jaw and midface for Maxillary-Mandibular Advancement (MMA)/BMA. This procedure is referred to as Phase two of the Powell-Riley phased protocol,[15] and gives the tongue more room and also places additional tension on the tongue base. There are various additional technologies for control of the tongue base which include radiofrequency volume reduction, electrical stimulation of the tongue by a pacing device, and a recently described suture technique to the tongue base. All of these technologies may be applied depending on their respective merits and published clinical outcomes.

*Clinical outcomes:* A tracheotomy is usually curative in that it bypasses the obstructive region regardless of the site. It is generally used in subjects with refractory (failures of medical and other surgical management) base of tongue obstruction and in those with medical conditions

that contraindicate more extensive surgeries. The techniques using soft tissue and skeletal procedure for the hypopharyngeal level have been used by our group in a staged manner so that the most conservative treatment is offered as an entry level management. We have named this approach to upper airway reconstruction the Powell-Riley phased surgical protocol and over the years it has proven to be an effective and safe method for controlling upper airway collapse in sleep-disordered breathing. It has additionally minimized the possibility that unnecessary surgery would be done. Our published clinical outcomes cure rate for phase one is 42% to 75% depending on the severity of the disorder. [16-18] Similar results have been confirmed by others.[19-21] Phase two has documented cure rates of greater than 90%.[10,17,22] Reported studies using BI-Maxillary Advancement surgery for the treatment of SDB gives results similar to our work.[23-26] Others have used laser midline glossectomy and lingualplasty or partial glossectomy with varied results depending on the definition they have reported for cure.

**Definition of Responder or Cure: (Powell-Riley)** Criteria must include 1-3 below or 4.

1. AHI $\leq$ 20 and /or at least a reduction in the AHI of 50% ( for example if the AHI is 25 then it must be by definition 12.5 after treatment to call a cure )
2. $Sa0_2 \geq$ 90% or a minimal fall below 90%
3. Normalization of sleep architecture
4. Equivalent comparison to nasal CPAP/BiPAP results on the second night of titration

**Definition of Phase One:** (**Powell-Riley** ) Three regions of the upper airway are treated as directed by the clinical work up using the most conservative surgery for each but only including treatment at that level if it was considered sufficiently obstructed.

*Nasal:* Correct nasal obstruction depending on anatomical deformity (septum, turbinates or nasal valve deformities).

*Pharyngeal:* UPPP or equivalent and tonsillectomy if tonsils present.

*Hypopharyngeal:* Inferior sagittal mandibular osteotomy and genioglossus advancement, hyoid myotomy and suspension, or laser midline glossectomy and lingualplasty, or partial glossectomy.

After phase one is completed a period of 4-6 months is allowed for sufficient healing, weight stabilization and neurologic equilibration. Then a repeat polysomnogram accompanied with a sleep assessment and clinical examination is done to assess the clinical outcomes.[27] Those patients who are unchanged or incompletely treated are offered either further surgery (Phase two) or medical management (CPAP).

**Definition of Phase Two:** (**Powell-Riley**)

If our protocol was used previously the only region that should be left incompletely treated is the hypopharynx (base of tongue) and Maxillary Mandibular Advancement (MMA).

A choice now is to be made to consider the remaining methods which are Maxillary Mandibular Advancement (BMA) surgery, tracheotomy or nasal CPAP. Other techniques that could be considered to make addition room for the tongue are the laser midline glossectomy and lingualplasty or partial glossectomy. These procedures are seldom used by our center for phase two. Base of tongue reduction using Temperature Control Radiofrequency (TCRF) to become an alternative to MMA/BMA surgery in some patients.[28]

**Bibliography:**


1. Kuhlo W, Doll E, Franck M: Erfolgreiche Behandlung eines Pickwick Syndroms durch eine Dauer-trachealkanule. Dtsh Med Wochenschr 94:1286-1290, 1969
2. Powell N, Riley R: A surgical protocol for sleep disordered breathing. Oral Maxillofacial Surg Clin North Am 7:345-356, 1995
3. Sher A, Schechtman K, Piccirillo J: An American Sleep Disorders Association Review: The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. Sleep 19:156-177, 1996
4. He J, Kryger M, Zorick T, et al: Mortality and apnea index in obstructive sleep apnea: Experience in 385 male patients. Chest 94:9-14, 1988
5. Dayal V, Pillipson E: Nasal surgery in the management of sleep apnea. Ann Otol Rhinol Laryngol 94:550-554, 1985
6. Millman R: Sleep Apnea and nasal patency, Am J Rhinol 2:177-182, 1988
7. Olsen K, Kern E, Westbrook P, et al: Sleep and breathing disturbance secondary to nasal obstruction. Otolaryngol Head Neck Surg 89:804-810, 1981
8. Series R, St Pierre S, Carrier G: Effects of surgical correction of nasal obstruction in the treatment of obstructive sleep apnea. Am Rev Respir Dis 46: 1261-1265, 1992
9. Suratt P, Turner B, Wilhoit S: Effect of intranasal obstruction on breathing during sleep. Chest 90:324-328, 1986
10. Sher A, Schechtman K, Piccirillo J: An American Sleep Disorders Association Review: The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. Sleep 19:156-177, 1996
11. Sher A, Thorpy M, Shprintzen R, et al: Predictive value of Muller maneuver in selection of patients for uvulopalatopharyngoplasty. Laryngoscope 95:1483-1487, 1985
12. Fujita S, Woodson T, Clark J, et al. Laser midline glossectomy as a treatment for obstructive sleep apnea. Laryngoscope 1991;101:805-09
13. Mickleson S, Rosenthal L: Midline glossectomy and epiglottidectomy for obstructive sleep apnea syndrome. Laryngoscope 1997;107:614-19
14. Powell, N B, Riley, R W, Troell R J, Blumen M B, Guilleminault C. Radiofrequency volumetric reduction of the tongue. A porcine pilot study for the treatment of obstructive sleep apnea syndrome. Chest 111:1348, 1996.
15. Powell NB, Riley RW, Guilleminault C: Rational and indications for surgical treatment in obstructive sleep apnea syndrome. Operative Techniques Otolaryngol Head Neck Surg 2(2): 87, 1991.

16. Riley R, Powell N, Guilleminault C: Inferior mandibular osteotomy and hyoid myotomy suspension for obstructive sleep apnea: a review of 55 patients. J Oral Maxillomaxfac Surg 47:159, 1989.
17. Riley R, Powell N, Guilleminault C: Obstructive sleep apnea syndrome: a review of 306 consecutively treated surgical patients. Otolaryngol Head Neck Surg 108:117, 1993
18. Riley R, Powell N, Guilleminault C. Obstructive sleep apnea and the hyoid: a revised surgical procedure. Otolaryngol Head Neck Surg 111: 717, 1994.
19. Ramirez SG, Loube DI: Inferior sagittal osteotomy with hyoid bone suspension for obese patients with sleep apnea. Arch Otolaryngol Head Neck Surg 122: 953, 1996.
20. Johnson, NT, Chinn J: Uvulopalatopharyngoplasty and inferior sagittal mandibular osteotomy with genioglossus advancement for treatment of obstructive sleep apnea. Chest 105: 278, 1994.
21. Lee RN, Givens CD, Wilson J, Robins RB: Staged surgical treatment of obstructive sleep apnea syndrome: A review of 35 patients. J Oral Maxillofac Surg 57:382-385, 1999
22. Powell, N B, Riley, R W, Guilleminault C: The hypopharynx: upper airway reconstruction in obstructive sleep apnea syndrome. D N F Fairbanks and S Fujita (eds). In Snoring and Obstructive Sleep Apnea, Second Edition. Raven Press, Ltd., New York 1994.
23. Waite PD, Wooten V, Lachner J, et al: Maxillomandibular advancement surgery in 23 patients with obstructive sleep apnea syndrome. J Oral Maxillofac Surg 47: 1256,.1989
24. Waite P, Shettar S: Maxillomandibular advancement surgery: a cure for obstructive sleep apnea syndrome. In: Waite P (editor). Oral and maxillofacial Surgery Clinics of North America 7(2): 327, 1995.
25. Hochban W, Brandenburg U, Peter JH: Surgical treatment of Obstructive sleep apnea by maxillomandibular advancement. Sleep 17(7):624, 1994.
26. Hochban W, Conradt R, Brandenburg U, et al: Surgical maxillofacial treatment of obstructive sleep apnea. Plastic and Reconstructive Surgery 99 (3): 619, 1995
27. Guilleminault C, Mondini S: Need for multi-diagnostic approaches before considering treatment in obstructive sleep apnea. Bull Eur Physiopathol Respir 1983;19:583-589
28. Powell, N B, Riley, R W, Guilleminault C: Radiofrequency tongue base reduction in sleep-disordered breathing: A pilot study. Otolaryngol Head Neck Surg 1999: 220:656-64

Words 3,234