Surgical Treatment of Snoring and Obstructive Sleep Apnea: ENT Perspective

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Snoring and Obstructive Sleep Apnea

Snoring is a common problem encountered in Thailand. The actual prevalence of snoring in Thailand is unknown, but it is estimated to be about 20% in middle-aged male and 5% in middle-aged female in foreign countries.[1] The percentage of elderly people who snore is higher. Most people understand that snoring is normal in daily life, but it actually indicates upper airway obstruction. It is also very annoying to patients' bed partners as it could deprive them from proper and restful sleep, which is essential to good health. Snoring most often results from collapse of excess soft tissue in the soft palate, tonsillar pillars, tongue, tongue base, and hypopharyngeal walls (Fig 1). If the degree of such an obstruction is severe, it can lead to obstructive sleep apnea (OSA) which is a life-threatening condition. OSA affects about 4% of middle-aged men and 2% of middle-aged women.[2] Snoring and OSA belong to a broad group of breathing abnormalities termed sleep-disordered breathing (SDB). OSA is characterized by periodic collapse of the upper airway during sleep, which leads to either complete (apneas) or partial airway obstruction (hypopneas), or both, resulting in arousal and oxygen desaturation. Risk factors for this condition include obesity, anatomical abnormalities, aging, male gender, and family history. Recognition of OSA is important since it causes daytime somnolence, neurocognitive defects, chronic fatigue, and depression. In addition, it can increase the risk of traffic accident, hypertension, cardiovascular disease, stroke, pulmonary hypertension, and cardiac arrhythmia.

From clinical point of view, the most important practical points are: firstly, the differentiation among primary snoring, upper airway resistance syndrome, and OSA; and secondly, the quest for point(s) of airway obstruction. The former can be done by overnight polysomnogram, which remains the gold standard for the diagnosis of OSA. The latter can be achieved by rigid and flexible endoscopy of the upper airway.

Treatment

The treatment options for SDB include weight loss, positional therapy, oral devices, continuous positive airway pressure (CPAP), and surgery. Surgery offers a viable alternative to nasal CPAP in patients who are intolerant of nasal CPAP. Potential risks and complications must be explained fully to any potential surgical candidate. The selection of surgical procedure(s) should be determined based on a patient's airway anatomy, medical status, severity of sleep apnea, and his or her desire and preference. The aim of surgical treatment of SDB is to enlarge the size of upper airway and correct anatomic abnormalities at multiple levels of the upper aerodigestive tract. The point of obstruction in the upper airway starts from nasal cavity, nasopharynx, oropharynx, and hypopharynx. The most common site of obstruction in adult is the oropharynx and hypopharynx. The type of surgery depends on the type and location of the pathology. There are usually multiple, difficult-to-evaluate sites of airway collapse, which make it challenging to predict which operation will be beneficial. Thus, determination of the site (or level) of obstruction is a predictor of the success or failure of any proposed surgery. The surgical correction of obstruction at one level has a limited success because there are usually multiple sites of airway obstruction especially in patients with moderate to severe OSA, which explains why surgery is often less successful than CPAP in treating OSA.

1) Nasal and/ or nasopharyngeal surgery

Surgery for correction of nasal obstruction has been shown to have beneficial effects on nocturnal nasal breathing in patients with SDB. It not only helps to relieve nasal obstruction, but also facilitates the use of nasal CPAP.[3] A variety of procedures are available to correct nasal obstruction secondary to deviated nasal septum (e.g. septoplasty), turbinate hypertrophy [submucous diathermy, radiofrequency volumetric tissue reduction (RFVTR), outfracture of the turbinate, submucous turbinoplasty, turbinectomy, intraturbinal use of Nd:YAG laser], or nasal valve abnormalities. Yariktas and colleagues[4] reported a significant improvement in snoring complaints in patients undergoing septoplasty for causes other than snoring. However, one recent study shows that although nasal surgery significantly decreased nasal resistance, it did not seem to decrease snoring intensity, snoring time, or SDB in an objective assessment by postoperative polysomnogram.[5] Patients who benefit most from correction of nasal obstruction as a sole intervention are probably those with the mildest forms of SDB without other significant predisposing anatomic abnormalities.

Adenotonsillar hypertrophy is the major cause of OSA in children. Tonsillectomy and adenoidectomy are effective in improving the physical sequelae and quality of life of affected children.[6]

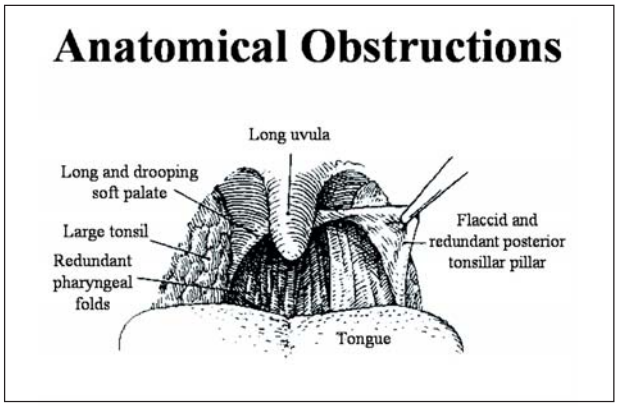

Fig 1. Intra-oral view demonstrates some anatomical obstructions which lead to upper airway narrowing

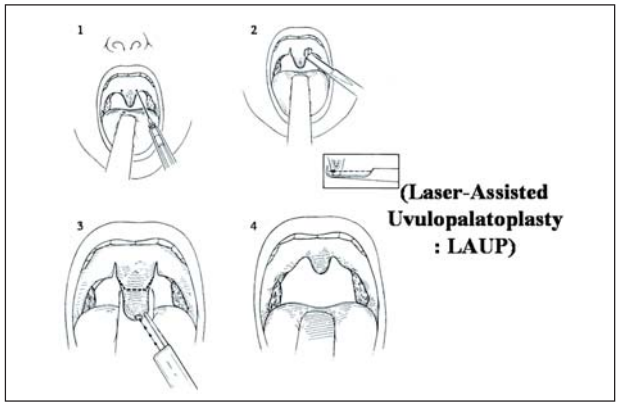

Fig 3. Diagrammatic procedure of laser-assisted uvulopalatoplasty

2) Oropharyngeal surgery

The surgical options available for obstruction at the oropharyngeal level are, namely:

2.1) Uvulopalatopharyngoplasty (UPPP) (Fig 2) is the most common surgical procedure performed for SDB. It is designed to eliminate palatal and pharyngeal redundancy by resection of excess loose palatal and pharyngeal mucosal and submucosal tissues. It is recommended for treatment of nonobese or mildly obese snorers with mild to moderate OSA who are resistant to (or intolerant of) CPAP and in whom correctable anatomical abnormalities in the oropharyngeal and palate areas are identifiable. The advantage of UPPP over other outpatient uvulopalatal procedures is the pharyngeal component of the procedure. Removal of tonsils and other redundant pharyngeal folds is followed by lateralization, suture fixation, tightening, and stabilization of the pharyngeal airway below the palatal level. Reported complications include airway obstruction, hemorrhage, velopharyngeal incompetence and nasopharyngeal stenosis. Metaanalysis of the data indicates a success rate of only 40%.[7] Submucosal UPPP has been introduced by Friedman and colleagues[8] to provide faster wound healing, less postoperative pain, and sutureline dehiscence.

2.2) Laser-assisted uvulopalatoplasty (LAUP) (Fig 3) is an outpatient surgical procedure which the uvula and soft palate are reduced and reshaped with the CO_2 laser to increase the size of oropharyngeal airway and reduce the vibratory soft tissue. It excises only the uvula and associated soft-palatal tissues and does not remove or alter the tonsils or lateral pharyngeal-wall tissues. LAUP is most often performed to alleviate snoring. It provides good and lasting results if it is performed correctly in properly selected patients. The intensity of snoring can be reduced up to 75%. Snoring reduction is assessed 4 to 6 weeks after surgery to determine whether additional treatments are needed. The procedure could be repeated if the patients still snore. Ferguson and colleagues[9] performed a randomized trial of LAUP in the treatment of mild OSA [respiratory disturbance index (RDI) =10-27 per hour]. Overall post-LAUP RDI was reduced by 21% compared with no change in control group; 48% of the patients reported significantly improved snoring after LAUP. Kern and colleagues[10] demonstrated that LAUP with adjunctive tonsillectomy is an effective treatment for patients with moderate to severe OSA and retropalatal obstruction with a lower complication rate than UPPP. Furthermore, Prasad and colleagues[11] reported partner satisfaction, following LAUP and UPPP using questionnaire-based survey, with a minimum follow-up of 1 year. There was a highly significant reduction in the disturbance of sleep and need to wake up and a significant improvement in quality of life after both types of surgery although residual snoring and the presence of trouble; falling asleep after LAUP was more frequently than it after UPPP. These studies demonstrate the effectiveness of LAUP in the treatment of SDB. Electrocautery can also be used for outpatient cautery-assisted uvulopalatoplasty in which tissue excision is the same as LAUP. This technique is more economical and does not require special training or extra safety precaution.

2.3) Uvulopalatal flap (UPF) (Fig 4) A one-stage UPF is a relatively new palatal technique, which can be performed in the outpatient setting under local or general anesthesia. The mucosa over the lingual surface of the uvula and soft palate is removed with cold knife

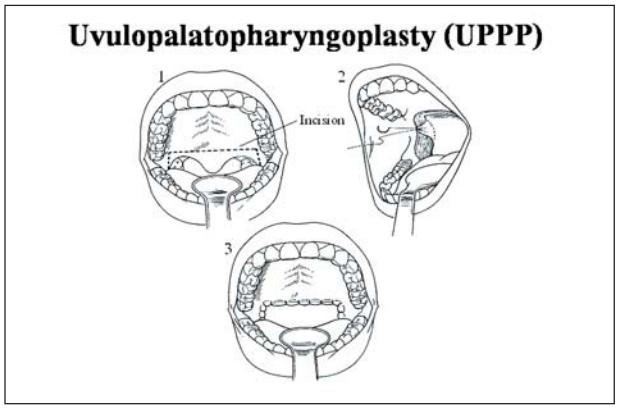

Fig 2. Diagrammatic procedure of uvulopalatopharyngoplasty.

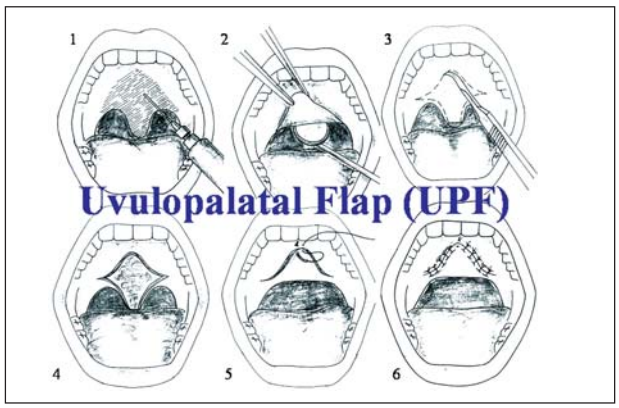

Fig 4. Diagrammatic procedure of uvulopalatal flap

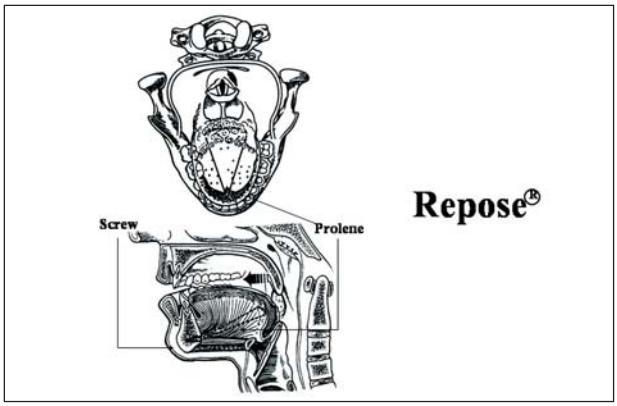

Fig 5. Suspension suture for stabilization of the tongue base

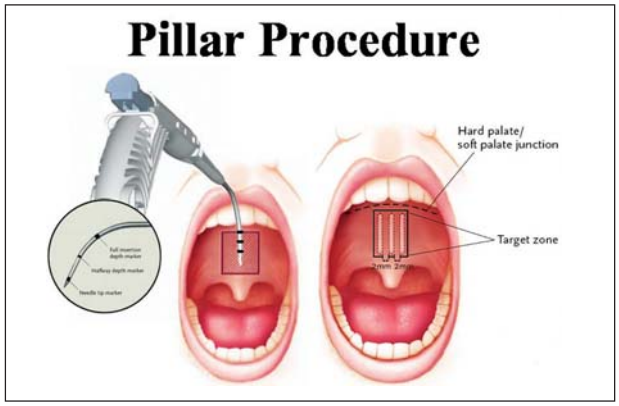

Fig 7. Pillar procedure

dissection. The uvular tip is amputated, and reflected up toward the soft palate and sutured. Although LAUP is technically easy to perform, it has several drawbacks, as it requires the availability of a laser machine and may last several months in multiple procedures. UPF is a simple procedure and does not require additional equipment. It offers potential advantages over the traditional UPPP in maintenance of palatal dynamics, lessened chance of scar contracture, reversibility, and lessened pain. Neruntarat assessed the safety and efficacy of UPF for the treatment of simple snoring under local anesthesia.[12] Significant improvement was observed in snoring scale and mean snoring index with the overall success rate of 88%. Li and colleagues[13] reported favorable surgical outcomes of a modified UPPP-extended UPF, which consisted of bilateral tonsillectomy, dissection and removal of submucosal adipose tissue of the soft palate and supratonsillar area, imbrication, and reposition of the denuded uvulopalatal flap in the treatment of OSA. Six months after operation, there was a significant decrease in mean RDI and a significant improvement in mean minimal oxygen saturation and snoring index.

2.4) Injection snoreplasty is a popular technique as a primary treatment of palatal snoring. A sclerotherapy agent is injected submucosally into the midline of the soft palate to induce fibrosis, which diminishes palatal flutter snoring. It is simple to perform, minimally painful, highly effective, and inexpensive. Satisfaction in terms of decreased snoring severity for the treatment of simple snoring was reported by 76.7% of the patients who underwent injection snoreplasty compared with 87.5% of those who received RFVTR of the soft palate.[14]

2.5) Tonsillectomy is indicated in patients with SDB who have enlarged tonsil. Tonsillectomy and adenoidectomy significantly improved behavioral and emotional difficulties and quality of life in children with documented OSA.[15] Lingual tonsillar hypertrophy can be relieved using laser vaporization. Suzuki and colleagues[16] performed lingual tonsillectomy using a new ultrasonic coagulating dissector (SonoSurg®) in patients with snoring and OSA. This instrument converts ultrasonic vibrations into energy, which minimizes bleeding by coagulating during tissue cutting. The investigator found that the operative time was shortened, and it was effective and safe as patients had less postoperative hemorrhage and pain, faster recovery with shorter stays.

2.6) Procedure for tongue base hypertrophy and collapse As narrow retrolingual space is a problematic component of OSA, treatment of this area requires invasive surgery with high morbidity. This is a new minimally invasive technique which has been described that achieves stabilization of the tongue base (Repose®). (Fig 5) It uses a soft tissue to bone anchor inserted intra-orally into the mandible with an attached prolene suture that is passed through the tongue. Rigidity is added to the airway after incorporation of the suture in the tongue musculature. The tongue base suspension combined with UPPP has been shown to reduce RDI better than UPPP alone. This minimally invasive technique is highly successful at 81.81% when combined with UPPP in the severe OSA patients with multilevel airway collapse.[17] In addition, the middle part of tongue base can be resected using laser (laser midline glossectomy). The insertion of genioglossus muscle can be advanced

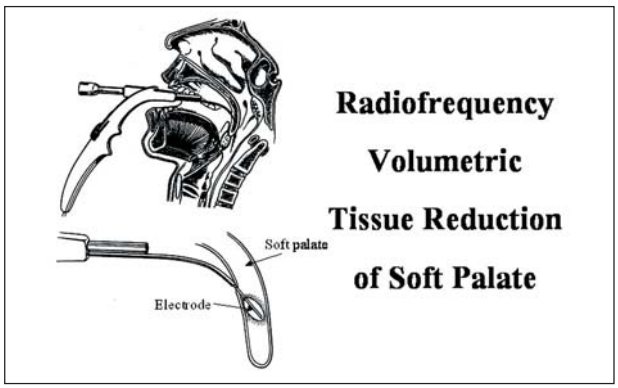

Fig 6. Diagrammatic procedure of radiofrequency volumetric tissue reduction of the soft palate

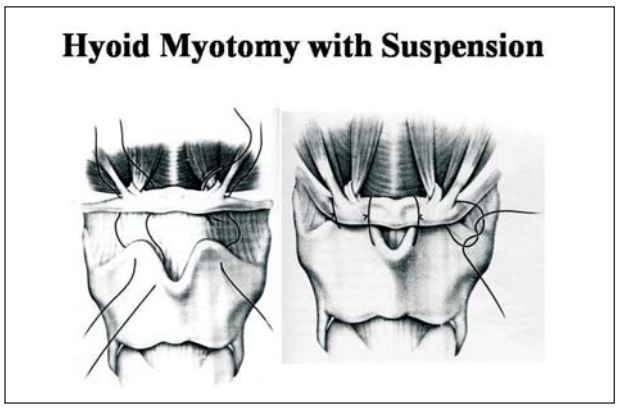

Fig 8. The hyoid myotomy and suspension procedure

anteriorly through mandibular osteotomy to increase the retrolingual space.

2.7) Radiofrequency volumetric tissue reduction (RFVTR) The novel radiofrequency procedures are technically simple, minimally invasive and are associated with reduced postoperative pain and discomfort compared with traditional surgical procedures. It can be performed as an outpatient basis under local anesthesia with a low complication rate and good therapeutic results.[18] A current from the electrode causes electrical arcs to form across the physical gap between the probe and the target tissue. At the contact point of these arcs, rapid tissue heating occurs. Consequently, cellular fluid rapidly vaporizes into steam, causing the release of cellular fragments and producing a layer of necrosis or dead cells along the pathway of the probe. As a result of this heating, collateral tissue ablation is produced in regions surrounding the target tissue site. This leads to the creation of a vascular degeneration in the affected tissue. Over a course of several weeks following the initial treatment, firmer fibrous tissues forms reducing the tissue volume with less vibration. Soft palatal radiofrequency (Fig 6) reduces the volume of palatal soft tissue and produces scar tissue to alleviate velophayngeal vibration and collapse in snoring and mild SDB. In a randomized, placebo-controlled trial, RFVTR of the soft palate was significantly better than placebo in improving snoring.[19] Said and Strome[20] conducted telephone interviews to assess the long-term efficacy (average follow-up of 14 months) and morbidity of RFVTR of the soft palate for snoring. The majority of patients responded favorably to treatment without significant complications or long-term sequelae. Rombaux and colleagues[21] recently compared the side effects and the postoperative complications of UPPP, LAUP, RFVTR, 3 procedures commonly used for the treatment of primary snoring. The data reveal that RFTVR is a safer and less painful procedure and has less complication rate than UPPP and LAUP. Postoperative discomfort after LAUP and after UPPP appears to be very similar. However, the success rate of RFTVR of the soft palate is lower compared to the more invasive technique of UPPP.[22]

RFVTR for hypertrophic inferior turbinate is effective in patients with retractable nasal obstruction who have failed conventional treatments. Radiofrequency tongue base reduction is an alternative technique of improving upper airway patency by reducing the size of the tongue. This modality is a multiple-staged procedure separated by approximately 4 weeks, performed in an outpatient setting using local anesthesia with minimal discomfort and morbidity. Fischer and colleagues[23] evaluated the safety and efficacy of multilevel radiofrequency application to soft palate, tonsils, and base of tongue in 15 patients with moderate to severe OSA. There were significant decreases in score on Epworth sleepiness scale, their daytime sleepiness, snoring score, and RDI with low complication rate. This study has shown that radiofrequency offers the potential of altering the upper airway size in patients with moderate to severe OSA.

Radiofrequency-assisted uvulopalatoplasty (RAUP) is similar to LAUP, but it is done with a radiofrequency instrument, instead of laser. A special radiofrequency electrode is used to make two vertical cuts on either side of the uvula. These are joined by a horizontal cut and the uvula is removed. Most patients are able to return to work in the following day. Wedman and Miljeteig[24] performed RAUP in 40 male social snorers and followed up until 3 months postoperatively. Snoring sounds and daytime tiredness reduced significantly. The relative small investments needed and its simplicity makes RAUP a good alternative to known treatment strategies.

Coblation method replaces the extreme heat of laser and standard electrosurgery with a gentle heating of the tissues causing physical reduction and shrinkage of the affected site. This is achieved by molecular disintegration via a plasma-mediated cold ablative process compared to the gradual and slow vacular degeneration produced by radiofrequency procedures. Thus, Coblation results in rapid and precise volumetric tissue removal with little or no collateral tissue damage. In addition, it can simultaneously achieve coagulation of smaller blood vessels within few seconds rather than several minutes with a delayed response like radiofrequency. Its efficacy in volumetric tissue removal has been clearly demonstrated in tonsillectomy[25] and inferior turbinate reduction procedure.[26]

2.8) Pillar procedure (Fig 7) is another technique by inserting three tiny woven polyester into soft palate and stiffen the soft palate leading to reduced both vibration and collapse of the soft palate to obstruct the airway. Rather than surgical removal of tissue, the procedure is designed to reinforce the soft palate. The inserts induce a natural tissue response that secures them within the palate and provide structural support to the soft palate. It is a new surgical tool offering a simple, safe, effective and minimally invasive procedure with good patient acceptance. It has been shown to reduce snoring and daytime sleepiness at the 3-month follow-up[27] and over a period of one year[28] without complications.

3) Hypopharyngeal surgery

Hyoid myotomy with suspension (Fig 8) and a mandibular osteotomy with genioglossus muscle advancement provide a high rate of surgical success. Neruntarat[29] performed hyoid myotomy with suspension in the treatment of hypopharyngeal obstruction in 32 patients with OSA under local anesthesia and assessed its safety and efficacy. There were significant decreases in RDI, Epworth sleepiness scale, snoring scale and a significant increase in the lowest oxygen saturation with a low probability of complications. Similar results were also found in another recent study.[30] Successful results of hyoid myotomy with suspension and genioglossus advancement under local anesthesia in the treatment of hypopharyngeal obstruction has been demonstrated.[31]

4) Other surgery

In retractable case, distraction osteogenesis can improve airway obstruction by expanding the maxillofacial skeleton. In individuals who require more aggressive advancement of the hypopharyngeal airway, maxillary-mandibular advancement is an effective mechanism to maximize their airway space. The surgical success rate of maxillomandibular advancement was 84% in one recent study.[32] Complications include bleeding, infections, upper airway obstruction, hematoma, and facial anesthesia.

If all treatment modalities fail, tracheostomy can be considered the final therapeutic option, especially in morbidly obese patients with severe OSA, significant oxygen desaturation, and/ or associated cardiac disease.

Sundaram and colleagues[33] reviewed randomized trials comparing any surgical intervention for OSA with other surgical or non-surgical interventions or no intervention and found that there are now a small number of trials assessing different surgical techniques with inactive and active control treatments. They concluded that the studies

assembled in the review do not provide evidence to support the use of surgery in OSA, as overall significant benefit has not been demonstrated. Long-term follow-ups of patients who undergo surgical correction of upper airway obstruction are required.

Most patients with OSA are obese with hypertension and other cardiovascular disease. They have difficult airways both at the intubation and after surgery. The care of these patients requires vigilance to minimize postoperative edema that prevents airway compromise and other complications. If the patients undergo surgery under general anesthesia, they should be closely monitored postoperatively in an intensive care unit setting by experienced staff. Since postoperative airway problems usually occur in patients who are undertaking combined multiple simultaneous surgeries, stage procedures are encouraged to avoid this potential complication. Intravenous corticosteroid can be given to reduce swelling or edema of the airway. It should be noted that apnea is aggravated by narcotics, and life-threatening loss of airway can be precipitated. Thus, antiemetics, sleeping medications, relaxants, and sedative tranquilizers should be avoided. The criteria for discharging the patients include having a secured airway, adequate fluid intake, and good pain controls.

CONCLUSION

There is clear association between OSA and morbidity and mortality. Although nonsurgical treatments are effective, most of them are limited by patient compliance. Surgical therapy is an alternative in patients who are intolerant of conservative treatments. Outcome data have demonstrated that surgical therapy can be successful in the treatment of SDB. A careful evaluation of location and cause of airway abnormality and proper selection of patients can result in improved clinical outcome, the patients' quality of life, and general health with minimal complications.

REFERENCES

1. Lugaresi E, Cirignotta F, Coccagna G, Baruzzi A. Snoring and the obstructive apnea syndrome. Electroencephalogr Clin Neurophysiol 1982;35 (Suppl):421-30.
2. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med 1993;328:1230-5.
3. Friedman M, Tanyeri H, Lim JW, Landsberg R, Vaidyanathan K, Caldarelli D. Effect of improved nasal breathing on obstructive sleep apnea. Otolaryngol Head Neck Surg 2000;122:71-4.
4. Yariktas M, Doner F, Dogru H, Tuz M. The beneficial effect of septoplasty on snoring. Kulak Burun Bogaz Ihtis Derg 2003;10:58-60.
5. Virkkula P, Bachour A, Hytonen M, Salmi T, Malmberg H, Hurmerinta K, et al. Snoring is not relieved by nasal surgery despite improvement in nasal resistance. Chest 2006;129:81-7.
6. Ray RM, Bower CM. Pediatric obstructive sleep apnea: the year in review. Curr Opin Otolaryngol Head Neck Surg 2005;13:360-5.
7. Sher AE, Schechtman KB, Piccirillo JF. The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. Sleep 1996;19:156-77.
8. Friedman M, Landsberg R, Tanyeri H. Middle turbinate medialization and preservation in endoscopic sinus surgery. Otolaryngol Head Neck Surg 2000;123:76-80.
9. Ferguson KA, Heighway K, Ruby RR. A randomized trial of laser-assisted uvulopalatoplasty in the treatment of mild obstructive sleep apnea. Am J Respir Crit Care Med 2003;167:15-9.
10. Kern RC, Kutler DI, Reid KJ, Conley DB, Herzon GD, Zee P. Laser-assisted uvulopalatoplasty and tonsillectomy for the management of obstructive sleep apnea syndrome. Laryngoscope 2003;113:1175-81.
11. Prasad KR, Premraj K, Kent SE, Reddy KT. Surgery for snoring: are partners satisfied in the long run? Clin Otolaryngol Allied Sci 2003;28:497-502.
12. Neruntarat C. Uvulopalatal flap for snoring on an outpatient basis. Otolaryngol Head Neck Surg 2003; 129:353-9.
13. Li HY, Li KK, Chen NH, Wang PC. Modified uvulopalatopharyngoplasty: The extended uvulopalatal flap. Am J Otolaryngol 2003;24:311-6.
14. Iseri M, Balcioglu O. Radiofrequency versus injection snoreplasty in simple snoring. Otolaryngol Head Neck Surg 2005;133:224-8.
15. Tran KD, Nguyen CD, Weedon J, Goldstein NA. Child behavior and quality of life in pediatric obstructive sleep apnea. Arch Otolaryngol Head Neck Surg 2005;131:52-7.
16. Suzuki K, Kawakatsu K, Hattori C, Hattori H, Nishimura Y, Yonekura A, et al. Application of lingual tonsillectomy to sleep apnea syndrome involving lingual tonsils. Acta Otolaryngol 2003;550(Suppl):65-71.
17. Omur M, Ozturan D, Elez F, Unver C, Derman S. Tongue base suspension combined with UPPP in severe OSA patients. Otolaryngol Head Neck Surg 2005;133:218-23.
18. Troell RJ. Radiofrequency techniques in the treatment of sleep-disordered breathing. Otolaryngol Clin North Am 2003;36:473-93.
19. Stuck BA, Sauter A, Hormann K, Verse T, Maurer JT. Radiofrequency surgery of the soft palate in the treatment of snoring. A placebo-controlled trial. Sleep 2005;28:847-50.
20. Said B, Strome M. Long-term results of radiofrequency volumetric tissue reduction of the palate for snoring. Ann Otol Rhinol Laryngol 2003;112:276-9.
21. Rombaux P, Hamoir M, Bertrand B, Aubert G, Liistro G, Rodenstein D. Postoperative pain and side effects after uvulopalatopharyngoplasty, laser-assisted uvulopalatoplasty, and radiofrequency tissue volume reduction in primary snoring. Laryngoscope 2003;113:2169-73.
22. Hofmann T, Schwantzer G, Reckenzaun E, Koch H, Wolf G. Radiofrequency tissue volume reduction of the soft palate and UPPP in the treatment of snoring. Eur Arch Otorhinolaryngol 2006;263:164-70.
23. Fischer Y, Khan M, Mann WJ. Multilevel temperature-controlled radiofrequency therapy of soft palate, base of tongue, and tonsils in adults with obstructive sleep apnea. Laryngoscope 2003;113:1786-91.
24. Wedman J, Miljeteig H. Treatment of simple snoring using radio waves for ablation of uvula and soft palate: a day-case surgery procedure. Laryngoscope 2002;112:1256-9.
25. Belloso A, Chidambaram A, Morar P, Timms MS. Coblation tonsillectomy versus dissection tonsillectomy: postoperative hemorrhage. Laryngoscope 2003;113:2010-3.
26. Bhattacharyya N, Kepnes LJ. Clinical effectiveness of coblation inferior turbinate reduction. Otolaryngol Head Neck Surg 2003;129:365-71.
27. Maurer JT, Verse T, Stuck BA, Hormann K, Hein G. Palatal implants for primary snoring: short-term results of a new minimally invasive surgical technique. Otolaryngol Head Neck Surg 2005;132:125-31.
28. Maurer JT, Hein G, Verse T, Hormann K, Stuck BA. Long-term results of palatal implants for primary snoring. Otolaryngol Head Neck Surg 2005;133:573-8.
29. Neruntarat C. Hyoid myotomy with suspension under local anesthesia for obstructive sleep apnea syndrome. Eur Arch Otorhinolaryngol 2003;260:286-90.
30. den Herder C, van Tinteren H, de Vries N. Hyoidthyroidpexia: a surgical treatment for sleep apnea syndrome. Laryngoscope 2005;115:740-5.
31. Neruntarat C. Genioglossus advancement and hyoid myotomy under local anesthesia. Otolaryngol Head Neck Surg 2003;129:85-91.
32. Smatt Y, Ferri J. Retrospective study of 18 patients treated by maxillomandibular advancement with adjunctive procedures for obstructive sleep apnea syndrome. J Craniofac Surg 2005;16:770-7.
33. Sundaram S, Bridgman S, Lim J, Lasserson T. Surgery for obstructive sleep apnea. Cochrane Database Syst Rev 2005;4: CD001004