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## Selected surgical managements in snoring and obstructive sleep apnea patients

### Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Data Interpretation
- E** Manuscript Preparation
- F** Literature Search
- G** Funds Collection

Ewa Olszewska<sup>ABCDI</sup>, Justyna Rutkowska<sup>BCDE</sup>, Aneta Czajkowska<sup>E</sup>,  
Marek Rogowski<sup>GD</sup>

Department of Otolaryngology, Medical University of Białystok, Białystok, Poland

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### Summary

#### Background:

The diagnostic process and the surgical procedures in patients with snoring and obstructive sleep apnea syndrome (OSAS) are crucial. The aim of this study was to assess the efficacy of surgical treatment in snoring and OSAS patients.

#### Material/Methods:

A precise laryngological examination and screening polysomnography (Poly-Mesam) were performed in all patients with mild, moderate and severe OSAS before and 6 months after surgery. The patients completed questionnaires concerning their complaints. We included patients qualified to septoplasty, laser-assisted uvulopalatoplasty (LAUP), uvulopalatopharyngoplasty (UPPP) and radiofrequency-induced thermotherapy of the tongue base (RITT). Outcome evaluation of surgery was performed on the basis of data received from follow-up laryngological examinations, selected parameters obtained from the Poly-Mesam test and follow-up questionnaires.

#### Results:

In most cases we observed improvement, defined as decreasing some sleep parameters, such as a respiratory disturbance index (RDI), by more than 50%, decreasing the loudness of snoring, decreasing the number of hypopneas, and obtaining better blood saturation values. After UPPP we noticed changes in retropalatal space, soft palate dimensions and uvula-posterior pharyngeal wall distance. In the postoperative period we did not observe severe complications. In some cases we found short-lived palatal deficiency after UPPP. Patients after RITT experienced discomfort and throat pain lasting from 2 to 4 days. In 2 patients we observed swelling of the tongue base, which decreased after few days.

#### Conclusions:

Surgery in OSAS contributes to normalization of some sleep parameters. The majority of patients experienced improvement after surgery.

#### key words:

snoring • sleep apnea syndrome • septoplasty • uvulopalatoplasty • uvulopalatopharyngoplasty • radiofrequency-induced thermotherapy

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#### Author's address:

Ewa Olszewska, Department of Otolaryngology Medical University of Białystok, Skłodowskiej 24A St., 15-276 Białystok, Poland, e-mail: ewaolsz@yahoo.com

## BACKGROUND

Snoring and obstructive sleep apnoea syndrome (OSAS) are prevalent and important causes of sleep disturbance. Snoring, historically considered to be only a habitual annoyance, has significant physical and social consequences. OSAS is now considered to be a major public health concern, with significant morbidity and mortality. It is a serious medical problem, producing both physical and behavioral derangement. It is essential to provide a thorough work-up and evaluation of all patients seeking care for snoring and apneas. OSAS is characterized by repeated narrowing or even collapse of the upper airway while breathing during sleep. It results in a continuum of increasing upper airway resistance, reduced blood oxygen levels, fragmentation of sleep and clinical manifestations from snoring alone to obstructive sleep apnoea, and cardiovascular and pulmonary complications. Cardiac arrhythmias may be associated with blood oxygen desaturation in patients with apnea or hypopnea episodes [1,2]. The daytime hypersomnia may lead also to occupational disability and behavioral changes. Sleepiness or sudden lapse into sleep is a well-recognized causal factor in traffic accidents. The death or disability of people in their productive years as the result of car crashes creates significant socioeconomic losses. The risk of traffic accidents in patients with sleep apnea syndrome may be 2–7 times as high as in normal healthy drivers. Adequate diagnosis and treatment of this condition significantly reduces the danger of crashes [3]. The pathophysiology of OSAS is related to local anatomical predispositions to OSAS, such as craniofacial anomalies, adenoid and tonsillar hypertrophy, macroglossia, and hypertonic oropharyngeal soft tissue, base of tongue proptosis, mandibular hypoplasia, posterior mandibular displacement, maxillary retrusion, enlarged uvula, retrognathia, and inferior positioning of the hyoid [4]. In most cases there are 3 areas that need to be taken care of by the laryngologist – the nasal cavity, the naso-pharyngeal space and the middle pharynx. These areas of the upper airways can be improved by surgery. Surgical approaches may also include hyoid advancement and suspension, septoplasty with turbinate reduction, tongue base excisions, myoplasty of tongue, and displacement of hyoid, maxilla or mandible fragments [5]. Continuous positive airway pressure mask (CPAP) is considered the treatment of choice for OSAS patients; however, poor patient acceptance has been observed, especially in younger patients, and mask expense, contraindications for using the mask and compliance remain problems. Surgical procedures have been developed to alter the offending anatomic abnormalities responsible for OSAS. Identification of the offending anatomic site with application of the most appropriate surgical procedure is essential for effective surgical treatment of OSAS. When the region of narrowing or upper airway collapse is indentified, the particular surgical procedure could be applied. Septoplasty, septorhinoplasty and laser mucotomy are suggested for snoring and OSAS patients when increased nasal air resistance is observed.

The first known mention of rhinologic surgery is in the 3500-year-old Ebers papyrus. One of the first studies of the role of nasal obstruction in patients with disturbed sleep, insomnia, nightmares, impaired intellect and memory was described by Carpenter in 1892 [6]. Most data concerning nasal surgery in patients with OSAS started in 1980s.

The role of nasal patency in the pathogenesis of OSAS is not fully understood. Chronic nasal obstruction is often caused by enlargement of the inferior nasal turbinate. It is commonly associated with anatomical and pathological conditions such as hypertrophic inferior turbinates, deviated septum and allergy [7]. Obstruction of the air flow due to mucosal swelling of the inferior turbinates may affect patients throughout the day as well as during sleep, and contribute to headaches, olfactory disturbances and sleep disorders such as snoring and obstructive sleep apnoea. The inferior nasal turbinates play an important role in protecting the pharynx and larynx from the effect of direct insult of airflow and have influence on entire lung resistance. There are conflicting data in the literature concerning the influence of the nasal resistance on RDI. It is important to use a minimally invasive, safe and effective method for volume reduction of hypertrophied turbinate. Instead of conventional surgery of the turbinates, laser CO<sub>2</sub> vaporization can be used [8]; however, the effectiveness of nasal surgery such as laser mucotomy reached 55% in a group of unselected mild-to-moderate OSAS patients. Snoring volume decreased to the level that did not disturb sleep of others in 75% of patients. These surgical procedures caused noticeable decrease of snoring volume that was corroborated both subjectively and objectively. At the same time, snoring was more reduced than was the RDI in a studied group of patients [9].

One of the most common surgical procedures used in OSAS patients is uvulopalatopharyngoplasty (UPPP). UPPP was described by Ikematsu in 1952. This method has become more popular since the 1980s when Fujita disseminated the procedure in the USA [10,11]. Its efficacy is generally accepted, and its use, especially in cases of obstructive sleep apnea syndrome, is the only treatment of the palatal velum at present practiced. It is a procedure used to remove excess tissue in the middle pharynx to widen the airway.

LAUP is a staged office-based procedure involving removal of excessive uvular mucosa and creation of transpalatal vertical troughs to effectively widen the retropalatal airway. It is mainly used as an alternative method to treat habitual snoring. LAUP was first performed by Kamami in 1988 [12]. The procedure can reduce the airway obstruction in the oropharynx level. LAUP is a simple, reliable surgical procedure performed in an office setting under local anesthesia, without hospitalization.

Tongue base radiofrequency volume reduction (RITT) has been proposed as a means of correcting the obstruction caused by the collapse or hypertrophy of the tongue base in patients having sleep-disordered breathing. It is a procedure performed under local anesthesia. The Celon system, which is a bipolar technique, allows for a more rapid energy transmission into the tissue.

## MATERIAL AND METHODS

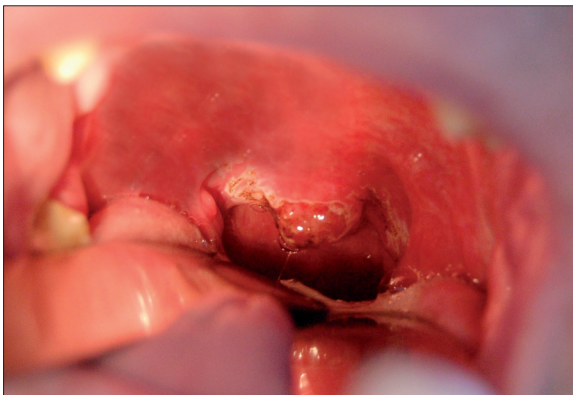
Seventy-nine randomly selected patients with snoring and varying degrees of sleep-disordered breathing were included in this study. Disease was suspected on the basis of a history of snoring in all patients, with or without daytime hypersomnolence or chronic fatigue. The study was approved by the Bioethics Committee and all patients signed the agreement to participate in the study. All patients were evaluated



**Figure 1.** Pharynx before laser assisted uvuloplasty.



**Figure 3.** Pharynx before RITT of the base of tongue.



**Figure 2.** Pharynx after laser assisted uvuloplasty.



**Figure 4.** Pharynx after RITT of the base of tongue.

by otolaryngological examination and rhinometry, which is an objective method for nasal resistance measurements. The study group consisted of 61 men and 18 women ranging in age from 38 to 71 years. All patients underwent preoperative testing using the Poly-Mesam test, a reliable, screening examination for recognition of the characteristics of ventilatory disorders and for diagnosis of OSAS, and all patients had preoperative craniofacial CT scans for cephalometric evaluation. Variables examined include age, sex, body mass index (BMI), respiratory disturbance index (RDI) and lowest oxygen saturation. We divided patients into 2 groups: snoring patients and OSAS patients. OSAS patients had an RDI of more than 5, minimal oxygen saturation less than 85% and snored more than 50% of their sleeping time.

The nasal patency to airflow was estimated by means of active anterior rhinomanometry (Rhinomanometry 300, Atmos 300, GmbH, Germany) using standard technique. Snoring or OSAS patients with hypertrophy of lower turbinates underwent CO<sub>2</sub> laser mucotomy under local anesthesia (1% Lidocaine) with a microsclad attached to a Sharplan 15-watt CO<sub>2</sub> laser. The patients were in supine position, with the head elevated to 30°. The procedure was performed by vaporizing the anterior 2–3 cm of each inferior turbinate. The average time of procedure was just few minutes. No antibiotics or other medications were used following surgery.

Snoring and OSAS patients with deviation of the nasal septum with increased nasal resistance underwent septoplasty under general anesthesia.

Snoring patients with hypertrophy in the middle pharynx (enlarged uvula, soft palate and palate-pharyngeal arches) underwent LAUP under local anesthesia (1% Lidocaine). Figure 1 illustrates the middle pharynx before the surgical procedure, showing the enlarged soft palate and enlarged mucosa of the uvula. We recommended LAUP procedure in the cases of snoring or respiratory disturbance index less than 5. It is not recommended for the treatment of sleep disordered breathing including OSAS. The mucosa of the uvula is partly removed, 2 paramedian full-thickness, through-and-through trenches are made over the soft palate on either side of the uvula to a height of 1–2 cm using the CO<sub>2</sub> laser. The average time of the procedure was only few minutes. If necessary, we could also repeat the procedure several times. We prefer this gentler procedure over the more radical one that removes uvular muscle. No antibiotics were used following surgery. Antiseptic spray and pain killers were usually useful. Figure 2 shows the middle pharynx after LAUP. The mucosa of the uvula and palate-glossal arches were vaporized during the procedure. No complications after the surgery were observed.

Patients with snoring or OSAS with enlarged mass of tongue base (at least III° in the Mallampaty scale) underwent radiofrequency-induced thermotherapy (RITT) under local anesthesia. We usually used 10% lidocaine spray on the base of tongue and 5 ml of 2% lidocaine with adrenaline (1:200000) administered on the surface of tongue. We administered between 8 and 16 lesions per session depending on the size of the tongue base. The needle is placed in

front of and behind the vallate papillae. We avoided placing the needle on the same location. We also do not recommend any antibiotics other than antiseptic spray and pain killers as needed. Figure 3 shows the enlarged base of the tongue. According to Mallampaty's scale, we estimated it as 3<sup>rd</sup> degree. The surgical procedure was made under local anaesthesia. We used the Celon system. In our experience we have been able to reduce the volume of the tongue base sufficiently to achieve improved patient breathing after 2 sessions (Figure 4.).

OSAS patients with hypertonic oropharyngeal soft tissue, enlarged tonsils, uvula and soft palate with RDI and AHI (apnea-hypopnea index) of more than 10 were classified for UPPP performed under general anesthesia. Antibiotics were always administered following surgery, as well as pain killers and antiseptic spray.

Postoperative evaluation was performed on the 1<sup>st</sup> day, 1<sup>st</sup> week, 1<sup>st</sup> month and 6 months after the surgery. Follow-up questionnaires and Poly-Mesam were done 6 months after the surgery.

## RESULTS

In most cases we observed improvement, defined as decreasing some sleep parameters such as a respiratory disturbance index (RDI) by more than 50%, decreasing the loudness of snoring, decreasing the number of hypopneas and better values of blood saturation.

Most patients from the study group experienced subjective improvement of their symptoms after laser mucotomy. No immediate major complications were observed. In 1 case we observed crusting and 1 patient complained of minor bleeding after the procedure. The present report has not been focused on histological findings of nasal mucosa and olfactory measurements. Nasal patency was improved (objectively measured by anterior rhinomanometry) after 3 months in 82% of patients who complained of disorder of air flow. Comparing the average resistance in the nasal cavity before and after turbinoplasty, we obtained significant reduction of nasal resistance rhinomanometry after 6 months, showing a reduction in mean total resistance from the pre-treatment level. In 8 patients we did not observe the reduction of nasal airway resistance. CO<sub>2</sub> laser mucotomy is an efficacious, minimally invasive and easy to use treatment of inferior turbinate hypertrophy, which can be performed under local anesthesia with little discomfort for the patient and does not require hospitalization. It is an effective treatment for nasal obstruction in snoring and mild OSAS patients.

After UPPP we noticed changes in retropalatal space, soft palate dimensions and uvula-posterior pharyngeal wall distance. In the postoperative period we did not observe any severe complications. In some cases we found short-lived palatal deficiency, changes in smell and taste, pharyngeal dryness, globus sensation, voice and pharyngonasal reflux after UPPP.

LAUP is a well tolerated and quick procedure. The main complaint reported by patients was mild pain in the operated area during the first 5–7 days after the surgery. We observed 4 patients with severe throat pain that required pain

killers for 7 to 9 days. We did not observe any other complications. The loudness of snoring decreased significantly in most cases.

Patients who underwent RITT showed mild improvement in snoring and sleep parameters. It is crucial to perform further evaluation after 2 years. Patients after tongue base reduction sometimes experienced discomfort and throat pain lasting from 2 to 4 days. In 2 patients we observed swelling of the tongue base which decreased in few days.

## DISCUSSION

The upper airway obstruction during sleep in snoring and obstructive sleep apnea syndrome can be improved after surgical treatment. In this study we selected the following procedures for snoring patients: laser mucotomy, septoplasty, LAUP and RITT of the base of the tongue. For OSAS patients we performed CO<sub>2</sub> laser mucotomy, septoplasty, UPPP and RITT of the base of the tongue. The only treatment that was not performed for snoring patients was UPPP. We reviewed the available literature, and developed these practice parameters in compliance with the Standards of Practice Committee of the American Academy of Sleep Medicine as a guide to the appropriate use of this surgery. Littner et al emphasized that LAUP was not recommended for treatment of sleep-related breathing disorders, but it does appear to be comparable to uvulopalatopharyngoplasty (UPPP) for treatment of snoring. Individuals who are candidates for LAUP as a treatment for snoring should undergo a polysomnographic or cardiorespiratory evaluation for sleep-related breathing disorders prior to LAUP and periodic postoperative evaluations for the development of the same [13]. Surgical normalization of nasal resistance was emphasized by Sulisenti et al as a necessary requirement before uvular palatoplasty [14]. Surgical corrections of anatomic obstruction in the nasal cavity may include, for instance, correction of the nasal valve area, septoplasty, turbinate reduction and polypectomy [15–18]. Nasal surgery may be the indispensable procedure in the treatment of nasal continuous positive airway pressure (CPAP). Increased nasal resistance or obstruction is highly related to CPAP non-acceptance. Upper airway surgical treatments, such as radiofrequency reduction of the inferior turbinate, septoplasty, septoplasty with inferior turbinectomy and with inferior turbinate submucosal diathermy, and septoplasty with tonsillectomy may provide some benefits by reducing nasal CPAP pressure levels [19]. Surgical correction of severe nasal obstruction should be considered to facilitate treatment of OSAS patients with CPAP [20]. Patients using oral appliances can also obtain some benefits after decreasing nasal resistance due to nasal surgery [21]. We can generally assume that the reduction of nasal resistance significantly improves daytime fatigue and sleep quality of patients with snoring and sleep disordered breathing. Nasal surgery may reduce the sound intensity of snoring by 5–10 dB in only snoring patients [22]. With the majority of OSAS patients the normalization of nasal resistance leads to improved well-being and sleep quality, but not OSAS. The success rate of only nasal surgery for simple snoring is less than 20% [23]. The elevation of nasal resistance results in an increase in negative oropharyngeal pressure during inspiration. In this way nasal obstruction may also predispose to multilevel upper airway collapse. In an experiment with nasal obstruction in

healthy volunteers, a statistically significant increase in the number of obstructive hypopneas and obstructive apneas was observed. The nasal obstruction also influences rapid-eye-movement (REM) latency, showing change in sleep architecture [24]. On the other hand, proper nasal breathing leads to correct craniofacial growth. Mouth breathing is an important cause of abnormal craniofacial development. Mouth-breathing children are more likely to have a retruded mandible, more inclined occlusal and mandibular planes, a smaller airway space, and a smaller superior pharyngeal airway space. Juliano presented inadequate breathing through the nose as a factor directly associated with apnea-hypopnea index contributing to OSAS development in children [25]. Many studies evaluating subjective and objective reports of nasal surgery efficacy in patients with OSAS have generally reported more positive subjective responses as compared to objective responses on sleep-related polysomnographic parameters [17]. Significant subjective improvement in nasal resistance and relief from snoring and daytime sleepiness were found in the surgical group evaluated by Li et al. The influences of lower body weight index, less daytime sleepiness, and lower tongue position are also emphasized [26]. In a randomized, controlled trial of nasal surgery in 49 patients with moderate to severe OSAS and fixed nasal obstruction due to deviated septum, the success rate was only 15%. The ability to switch from oral to nasal breathing is an important determinant of a positive outcome of nasal surgery [27]. Significant improvements in AHI following nasal surgery in a group of patients with mild OSAS were observed in the patients with normal pre-operative cephalometry. This finding supports the meaning for pre-operative diagnostic and emphasizes the role of nasal obstruction with the absence of oropharyngeal narrowing and confirms a relationship between the nose and pharynx in the pathophysiology of OSAS [28]. Because of multilevel decrease in airway patency, some patients require multistage surgical treatment to achieve the best results. In some cases, combined surgical treatment of palatal and retroglossal obstruction may be required.

In our experience thermal tissue damage procedures seem to be minimally invasive, effective and safe for patients. Lasers have been widely used for medical applications due to their advantages such as directivity and controllable effects. The 3 types of laser tissue thermal interactions, depending on the degree and the duration of tissue heating that may be employed are hyperthermia, coagulation and volatilization. CO<sub>2</sub> laser treatment in LAUP consists of coagulation of the tissue. It causes an irreversible necrosis without immediate tissue destruction, with temperatures in the range of 50–100°C for approximately 1 second [29].

The significant improvement after the LAUP procedure is reported in most treated patients suffering from snoring. The elimination or reduction of complaints was reported in the first year of observation in more than 80% of patients [30].

Radiofrequency (RF) treatment of the tongue depends on soft tissue thermal destruction and final reduction in tongue size. The relatively long RF wavelengths penetrate deeply into the tissue. The kinetic energy induced by RF waves in cells finally transforms into thermal energy and cell death is induced [31]. In 1997 Powell first described the use of RF in the volumetric reduction of tongue tissue. It was reported

that the lesion size created initial edema, subsequent formation of scar tissue and a resultant reduction in the volume [32]. The risk of severe complications of RF treatment of the tongue is low, but risk of infections, lingual abscesses, hematomas, or ulcerations of the tongue should always be taken into consideration. No complications were observed in our study.

The reported success of UPPP is between 16% and 83% [33], depending on the definition of a positive outcome. Successful surgical outcome of UPPP may be defined as a 50% reduction in the AHI, or we can combine this criterion with an absolute AHI of 20 or less. UPPP combined with radiofrequency thermotherapy of the tongue base in selected patients with OSAS seems to be more successful than UPPP alone [34].

To date, there is no algorithm that can be applied to all patients suffering from snoring and OSAS. It is difficult to select the best individual treatment for patients because of the multifactorial etiology of this syndrome [35].

## CONCLUSIONS

Our results indicate that surgery in OSAS contributes to normalization in some sleep parameters. Most patients indicate subjective improvement after surgery. Identification of the offending anatomic site with application of the most appropriate surgical procedure is crucial for effective surgical treatment. Multilevel surgery after precise diagnostic testing may be required to obtain the best results.

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