B-ENT, 2017, **13**, 1-7

Surgical treatments for snoring

A.-V. Sabbe[1,2], J. De Medts[1,2] and K. Delsupehe[1]

[1]ENT Department, AZ Delta, Roeselare, Belgium; [2]ENT Department, University Hospitals Leuven, Leuven, Belgium

Key-words. Sleep-disordered breathing, snoring surgery, functional expansion pharyngoplasty, osteotomy, septoplasty, somnoplasty

Abstract. *Surgical treatments for snoring. Objectives:* To compare the results on snoring and sleepiness of different surgical treatments for sleep disordered breathing (SDB) including uvulopalatopharyngoplasty (UPPP), functional expansion pharyngoplasty (FEP), osteotomy, septoplasty with turbinoplasty, and somnoplasty.
Methodology: Between May 2011 and December 2015, 329 patients presenting with SDB underwent a dedicated clinical examination, drug-induced sleep endoscopy (DISE), and polysomnography (PSG). Of these, 84 patients underwent surgical treatment. Treatments were evaluated through 4 questionnaires (snoring intensity, snoring severity, Epworth Sleepiness Scale [ESS], and global snoring score) before and 6 weeks and 6 months after treatment. Treatment success was defined as a global snoring visual analog scale score (VAS) ≤ 3 at 6 months.
Results: The average age of the surgical group was 43 ± 11 years; the mean body mass index was 26 ± 3 kg/m^2; and 88% were male. The snoring scores decreased significantly for every surgical technique at 6 weeks and 6 months. A higher reduction in the median snoring scores was observed in patients receiving UPPP/FEP and osteotomy compared to somnoplasty and septoplasty. Treatment was successful in 88% of the UPPP/FEP group, 92% of the osteotomy group, 61% of the septoplasty group, and 64% of the somnoplasty group.
Conclusions: All surgical treatments effectively and persistently reduced snoring and sleepiness symptom scores. The highest rates of success were observed with osteotomies and UPPP/FEP procedures.

Introduction

The prevalence of sleep disordered breathing (SDB) has rapidly increased over the past 2 decades. An estimated 27% of middle-aged men and 12% of middle-aged women experience moderate to severe SDB.[1] On top of the social problem arising from SDB, its various effects on hypertension, endothelial damage, arrhythmias, modified cerebral blood flow, and oxygen desaturation lead to an increase in cardiovascular complications.[2]

Polysomnography (PSG) and drug-induced sleep endoscopy (DISE) are standard examinations increasingly used to evaluate patients with SDB. Obstructive sleep apnea (OSA) is diagnosed based on the criteria of the international classification of sleep disorders by the American Academy of Sleep Medicine (AASM). These patients are referred for continuous positive airway treatment (CPAP). We demonstrated that DISE reveals the level of obstruction, altering the management plan in 40% of patients.[3] Our group also showed that treatment based on a multidisciplinary plan is effective and safe across all treatment options.[4] Different surgical treatment options are available for non-apneic snoring.

Data comparing the effects of the different types of surgery are very scarce or lacking, especially in non-apneic snoring. Therefore, it is difficult to provide good presurgical counseling to patients. The aim of this study was to conduct a comparative effectiveness study of the different surgical treatments on snoring and sleepiness in patients with SDB.

Materials and methods

Study population, work-up, and treatment selection

We included all patients who presented at our hospital with SDB between May 2011 and December 2015. The study was approved by the institutional review board (Medical Ethical Committee) of our hospital and registered at http://www.clinicaltrials.be as trial B117201111290. All patients signed a written informed consent prior to inclusion in the study.

All patients underwent a complete diagnostic work-up including a dedicated standardized ENT

examination,[5] rhinomanometry, skin prick allergy testing, DISE, and PSG. Patients, if possible with their partner, completed a questionnaire that included the patients' characteristics such as body mass index, smoking, use of alcohol, sleep medications, etc.

A treatment was proposed after completing the full work-up and multidisciplinary consultation. The multidisciplinary team consisted of at least one ear, nose, and throat specialist, maxillofacial surgeon, pneumologist, and orthodontist. If PSG showed an Apnea–Hypopnea Index (AHI) >20, patients were initially referred for CPAP because this was the cut-off for reimbursement of CPAP in Belgium until December 2016. In patients with an AHI ≤ 20, the therapeutic options include a mandibular advancement device (MAD) or performing surgery. The results of the DISE were evaluated to decide which surgery to perform.[4] When there was a unilevel circular palatal collapse during DISE, a functional expansion pharyngoplasty (FEP) procedure of the palate was suggested. Patients included in the study prior to September 2014 underwent an uvulopalatopharyngoplasty (UPPP), which was modified to a FEP after September 2014. In cases with an unilevel anterior-posterior tongue base or epiglottis collapse on DISE and a positive effect of the Esmarch maneuver, a MAD was suggested. Alternatively, in young patients with similar findings and a retrognatic profile (skeletal class 2) bimaxillary osteotomies were considered. These patients were referred to the maxillofacial surgeon. In case of snoring and additional complaints of nasal obstruction and significant septal deviation and hypertrophic conchae on clinical examination, septal surgery with inferior turbinoplasty was performed. A patient with multilevel collapse, mild snoring intensity, and inadequate effect of the Esmarch maneuver was selected for a somnoplasty on the different levels including the palate, tongue base, and the inferior turbinates. A minority of adults (n = 2) with SDB and kissing tonsils with significant obstruction at the oropharynx level during DISE were selected for a tonsillectomy exclusively.

Patient flow

We included 329 patients with SDB who presented at our hospital between May 2011 and December 2015 (Figure 1). CPAP was proposed in 66 patients because the AHI was >20/h. Of the remaining patients, 44 were excluded due to missing test results. Fifty-seven patients did not want to proceed with the proposed treatment (septoplasty, n = 2; UPPP/FEP, n = 15; somnoplasty, n = 6; osteotomy, n = 2; MAD, n = 32) and dropped out of the study. Finally, non CPAP treatment was started in 162 patients. In this series we included a consecutive cohort of 84 patients who underwent a UPPP, FEP, osteotomy, septoplasty with turbinoplasty, or a somnoplasty for SDB in our unit.

Surgical procedures

All surgeries were performed under general anesthesia. The UPPP procedure[6] consisted of a cold dissection tonsillectomy, trimming of the soft palate and uvula, and suturing of the tonsillar pillars with monocryl 4.0. The FEP technique performed later involved splinting the lateral pharyngeal wall and advancing the soft palate. A supero-lateral repositioning of the palatopharyngeus muscle is created, which increases pharyngeal airspace and decreases pharyngeal collapse.[7] A bimaxillary osteotomy was performed by one maxillofacial surgeon, and was aimed at advancing 3 to 6 mm of the maxilla and 10 mm of the mandible. To achieve a stable occlusion, simultaneous orthodontic treatment was performed. The traditional Cottle technique was used to perform a septoplasty. By resecting the postero-inferior part and the tail of the inferior turbinate, and using unipolar cauterization, a bilateral inferior turbinoplasty was performed. Somnoplasty consisted of a radiofrequency ablation of the soft palate, tongue base, and inferior turbinates. With a bipolar electrode, 5 to 6 sites were treated with 10, 12, and 10 Watts, respectively.[8] Tonsillectomy was conducted by cold dissection.

Outcome measurements

All patients completed a questionnaire that included four symptom scores at three different time points (before treatment and 6 weeks and 6 months after treatment). Snoring intensity was rated using a visual analog scale (VAS) from 0 (no snoring) to 10 (intensity of snoring was a reason for the partner to sleep in a separate location) cm. Snoring severity consisted of duration, loudness, and frequency of snoring, each scored from 0 to 3, leading to a score of 0 to 9 for snoring severity.[9] The Epworth Sleepiness Scale (ESS) was used to measure the effect on daytime sleepiness (from 0 to 24). Finally,

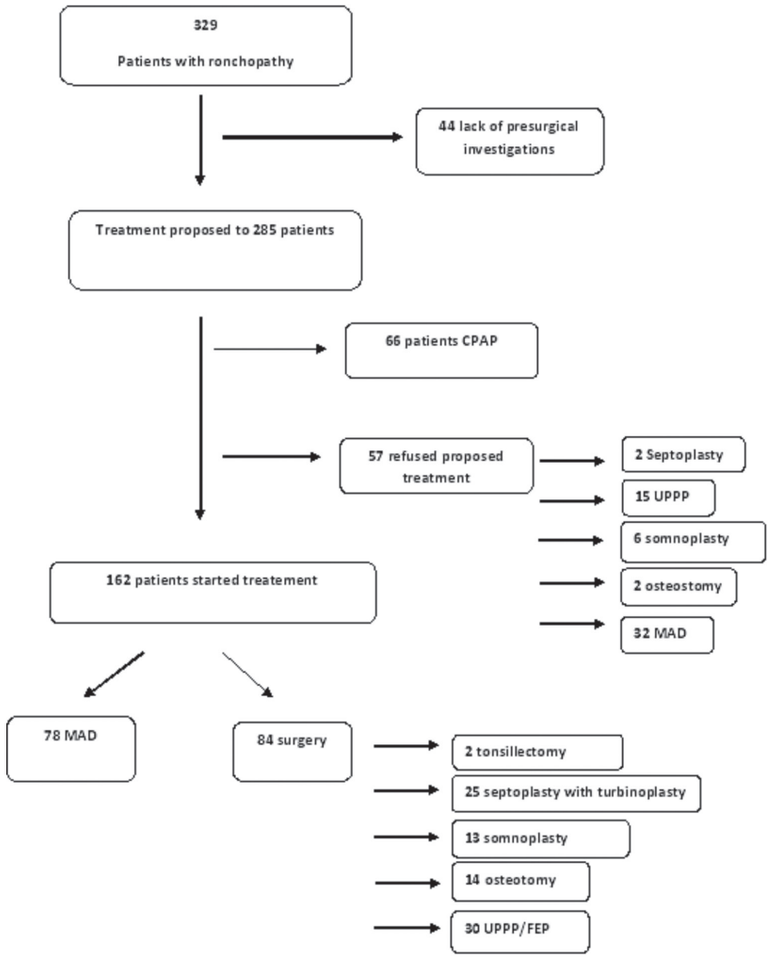

Figure 1
Patients disposition: flowchart of included patients

an overall snoring score using a VAS from 0 to 10 cm was included. Successful treatment was defined as a final snoring score of ≤ 3 on the VAS. Mild improvement was defined as a diminished VAS, but a score > 3. Adverse events were included in the questionnaire 6 months postsurgical. Patients had to indicate if they experienced an adverse event. Postoperative adverse events were recorded when reported.

Statistics

We used a paired t-test to evaluate the symptom scores pre- and postsurgery in the complete surgical group. A Wilcoxon signed rank test was used to compare the changes in the 4 different symptom scores within and between the different surgical groups pre- and postsurgery. Statistical significance was inferred at the P <.05 level. SPSS 20 (IBM Corporation, New York, 10504-1722, United States) was used for data analysis.

Results

Patient characteristics

Of the 329 patients presenting with SDB between May 2011 and December 2015, surgery was proposed in 109 patients. We report on 84 patients who consented for and underwent surgical treatment for SDB (tonsillectomy n = 2; septoplasty with turbinoplasty n = 25; somnoplasty n =13; osteotomy n = 14; UPPP/FEP n = 30). The average age of the surgical group was 43 ± 11 years; the mean body mass index was 26 ± 3 kg/m^2; and 88% were male. Baseline characteristics were very

similar for the different surgical groups, and did not differ from the entire group presenting with SDB (Table 1).

Surgical Outcomes

The snoring scores decreased significantly 6 weeks and 6 months after surgery in the complete surgical group. No significant differences were observed between the scores at 6 weeks and 6 months postoperation. The decrease in snoring was significant after 6 weeks Alterin every surgical group ($P < .05$) with the exception of the ESS. For the ESS score, a significant decrease was only observed in the UPPP/FEP group ($P = .002$) 6 weeks postoperatively. Six months postoperatively, the overall symptom scores decreased significantly ($P < .05$) to very significantly ($P < .001$) in all the individual groups except for the ESS score in the somnoplasty group ($P = .246$) (Figure 2).

When comparing the decrease in symptom scores among the different surgical treatments, superior results in the UPPP/FEP and osteotomy groups were observed compared to the somnoplasty and septoplasty groups at 6 months postoperatively. Treatment results showed no significant difference between UPPP/FEP and osteotomy. UPPP/FEP patients had significantly ($P < .05$) better scores (snoring intensity scale and snoring score) than patients in the septoplasty group. No difference was seen in the ESS ($P = .08$). Similar significant differences in decreased snoring intensity, severity, and score were noted ($P < .05$) for the osteotomy group versus the somnoplasty group. No significant differences in changes in symptom scores postoperatively were seen between the septoplasty and somnoplasty groups at 6 months.

On the level of the individual patient, the majority of patients in the UPPP/FEP group and the osteotomy group reported successful treatment. All patients in the UPPP/FEP and osteotomy groups report improvements in their symptoms. The great majority reported success, with 12% in the UPPP/FEP group and 8% in the osteotomy group experiencing mild improvement. More than 60% of patients reported success after septoplasty or somnoplasty. Mild improvement was reported in 30% in the septoplasty group and 27% in the somnoplasty group. No change was noted in 9% of patients in both groups (Figure 3).

One serious adverse event was noted in the UPPP group. A patient had to be hospitalized one night for observation because of post tonsillectomy hemorrhage. No revision surgery was needed. Minor adverse events included globus sensation, voice change, swallowing and speaking difficulties, and nasal regurgitation. These were mostly present in the UPPP/FEP group, but diminished by the 6-month postsurgical evaluation.

Discussion

With this comparative effectiveness study, we demonstrate that several surgical treatments for SDB patients, who were individually selected after a multidisciplinary consultation, can be very effective. After performing a dedicated clinical examination, a full diagnostic work-up with PSG, DISE, allergy testing, and rhinomanometry and a multidisciplinary consultation, an individualized surgical treatment was proposed. We report an effective and persistent reduction of the snoring and sleepiness symptom scores at 6 months postoperatively for all surgical procedures. Overall, about 77% of the patients reported treatment success, 19% reported mild improvement, and only 4% reported no change after the surgical treatment.

Table 1

Baseline characteristics of all patients presenting with SDB and those who underwent surgical treatment. *Values are means ± SD. †AHI post tonsillectomy: 6.9/h

Variable	Included (n= 329)	Surgical treatment (n = 84)	UPPP/FEP (n = 30)	Osteotomy (n= 14)	Septoplasty (n= 25)	Somnoplasty (n = 13)	Tonsillectomy (n=2)
Age, years *	46.9± 0.5	43.0± 1.5	42.7 ± 12.4	43.9 ± 8.5	40.4 ± 11.5	47.7 ± 10.4	33.5 ± 2.5
Body mass index, kg/m² *	27.1± 9.3	26.4 ± 3.4	26.7 ± 3.5	26.3 ± 3.1	25.5 ± 3.3	26.5 ± 3.2	28.0 ± 0.3
Male	75.5 %	88.1 %	86.7 %	92.9 %	90.9 %	84.6 %	100.0 %
Smokers	25.5%	26.2 %	30.0 %	28.6 %	27.3 %	15.4 %	0.0 %
AHI *			13.1 ± 7.9	12.0 ± 5.4	6.9 ± 9.5	4.4 ± 3.4	86.5†

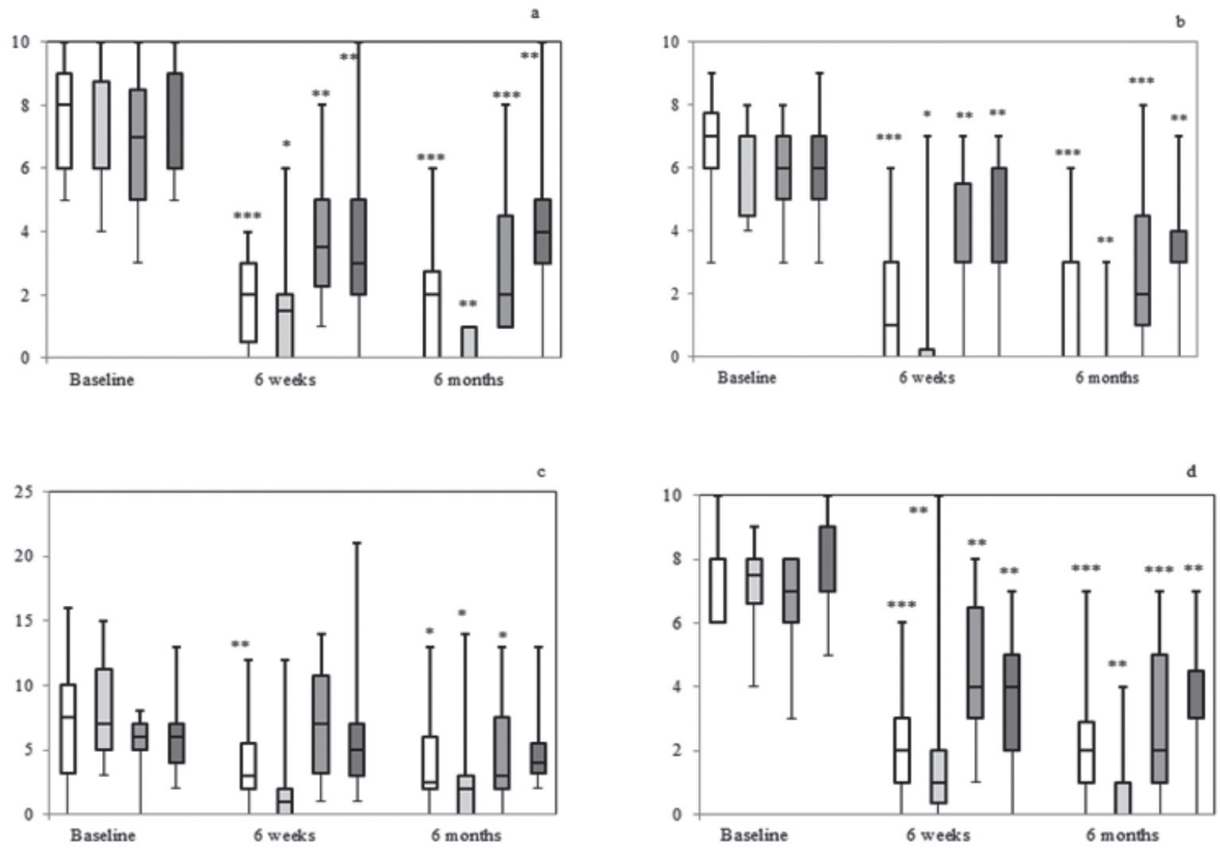

Figure 2

Overall snoring scores (boxplots representing medians and quartiles). Representation of the different snoring scores: (a) snoring intensity, (b) snoring severity, (c) ESS, and (d) snoring score.
FEP/UPPP; Osteomy; Septoplasty;Somnoplasty.
Statistical significance is depicted as follows * $P< 0.05$; ** $P<0.01$; *** $P<0.001$

Hence, we believe that our study provides new insights and guidance for counseling patients preoperatively.

This is not a randomized trial, but by using a standardized questionnaire prior to the operation, and by having patients complete the questionnaire at the same time postoperatively, this study compares the effectiveness of the different surgical options. A multidisciplinary consultation was essential to assure that the proposed surgical treatment was the best option for each individual patient. Therefore, the results of our study may differ from other trials comparing non individualized treatments or in non-selected patient populations.

A great majority (88%) of the UPPP/FEP patients reported successful treatment. The overall symptom scores decreased significantly 6 weeks after surgery and remained stable at 6 months. As in some other centers during the study period, we shifted from UPPP to the improved FEP technique. The shift from performing a UPPP to performing a lateral pharyngoplasty and the modified FEP was evaluated by Denizhan *et al.*[10]. The authors concluded that the increase in minimum oxygen saturation and the decrease in ESS postoperatively was higher in the pharyngoplasty group. Also, Cahali *et al.*[11] reported favorable results with pharyngoplasty. Several groups have published favorable results for FEP procedures in OSA patients.[12] In this study, we confirm good outcomes in SBD patients as well. We believe that the added benefit of the FEP procedure lies in widening the upper airway in the different dimensions, including anteroposteriorly and transversely. Our success

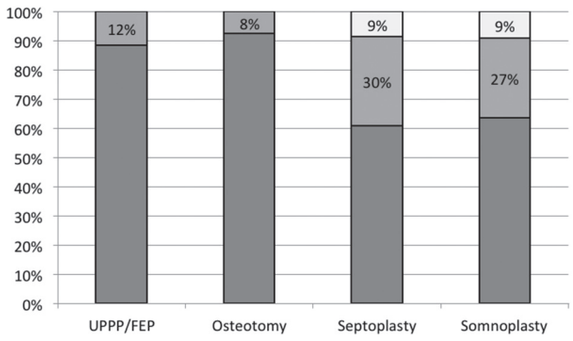

Figure 3
Individual treatment success rate according to global snoring visual analog scale score (VAS) for the different types of surgical procedures. No change in VAS; Mild improvement: VAS lowered but still > 3; Successful treatment: VAS postsurgical ≤3.

rate of 92% after performing an osteotomy in SDB patients correlates to the results seen in literature[13] in OSA patients. In contrast to Boyd *et al*.,[14] no significant difference was noted for osteotomy compared to a UPPP or FEP, but this was a comparative study in a similar patient population. In our study, surgeries were equally effective treatments for SDB when performed after careful patient selection.

As shown by Hsia *et al.,*[15] a significant pattern of snoring induced by nasal obstruction can be identified. These patients are mostly diagnosed with mild OSA. Recent reviews indicated the larger impact of septoplasty with turbinoplasty on snoring in SDB patients than on sleep apnea severity;[16] this was confirmed in our study. With only 9% of the patients who reported no change after septoplasty, we can state that septoplasty is an effective treatment for SBD in patients with complaints of nasal obstruction. Unlike the snoring scores, the ESS did not improve significantly. This can probably be explained by the fact that all patients in this study had an AHI < 20/h. Therefore, in this patient population sleepiness was not a major complaint, and ESS scores were as low as in the OSA group.

Furthermore we confirm the beneficial results of somnoplasty in a group of non OSA patients that were reported in a meta-analysis performed by Baba *et al*.[8] in OSA patients. Somnoplasty has been reported mostly in patients with mild to moderate OSA and thus correlates well with our population of patients with SBD. Temperature-controlled radiofrequency ablation or somnoplasty as a multilevel procedure is proven clinically effective on reducing the respiratory disturbance index and sleepiness.[8] In the literature, long-term results are lacking. In some studies, a decrease of benefit over time is noted, but this could be explained by patients' weight gain.

Limitation of our study include the relative small number of patients in the surgical subcategories, the non-randomized trial design, relatively short follow-up, and the fact that only non OSA patients were included.

Conclusion

In this comparative effectiveness study, we demonstrate that all the presented surgical treatments, selected after careful examination and a multidisciplinary consultation, effectively and persistently reduced snoring and sleepiness symptom scores. The highest rates of success were observed with osteotomies and UPPP/FEP procedures

Acknowledgements

We thank our colleagues Bernard Bouckaert, MD, from the Department of Pulmonology, Marc Vanden Bulcke, MDS, DDS, PhD, and Philippe Vuylsteke, MD, maxillofacial surgeon, for their contributions to this study by including patients and for their participation in the weekly multidisciplinary discussions.

References

1. Peppard PE, Young T, Barnet J, Palta M, Hagen EW, Hla KM. Increased Prevalence of Sleep-Disordered Breathing in Adults. *Am J Epidemiol.* 2013;177(9):1006-1014.
2. Birkbak J, Clark A, Rod N. The Effect of Sleep Disordered Breathing on the Outcome of Stroke and Transient Ischemic Attack: A Systematic Review. *J Clin Sleep Med.* 2014;10(1):103-108.
3. Pilaete K, De Medts J, Delsupehe K. Drug-induced sleep endoscopy changes snoring management plan very significantly compared to standard clinical evaluation. *Eur Arch Otorhinolaryngol.* 2014;271(5):1311-1319.
4. Terryn S, De Medts J, Delsupehe K. Comparative Effectiveness of the Different Treatment Modalities for Snoring; *Otolaryngol Head Neck Surg*. 2015;153(3):468-475.
5. Shah JA, George A, Chauhan N, Francis S. Obstructive Sleep Apnea: Role of an Otorhinolaryngologist. *J Otolaryngol Head Neck Surg.* 2016;68(1):71-74.

6. 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(2):164-170.
7. Sorrenti G, Piccin O. Functional expansion pharyngoplasty in the treatment of obstructive sleep apnea. *Laryngoscope*. 2013;123(11):2905-2908.
8. Baba R, Mohan A, Metta V, Mador M. Temperature controlled radiofrequency ablation at different sites for treatment of obstructive sleep apnea syndrome: a systematic review and meta-analysis. *Sleep Breath*. 2015;19(3):891-910.
9. Morris L, Kleinberger A, Lee K, Liberatore L, Burschtin O. Rapid risk stratification for obstructive sleep apnea, based on snoring severity and body mass index. *Otolaryngol Head Neck Surg*. 2008;139(5):615-618.
10. Dizdar D, Civelek Ş ÇaliŞZA, Dizdar SK, CoŞkun BU, Vural A. Comparative Analysis of Lateral Pharyngoplasty and Uvulopalatopharyngoplasty Techniques With Polisomnography and Epworth Sleepiness Scale. *J Craniofac Surg*. 2015;26(7):647-651.
11. Cahali M, Formigoni G, Gebrim E, Miziara I. Lateral pharyngoplasty versus uvulopalatopharyngoplasty: a clinical, polysomnographic and computed tomography measurement comparison. *Sleep*. 2004;27(5):942-950.
12. Pang K, Pang E, Win M, Pang K, Woodson B. Expansion sphincter pharyngoplasty for the treatment of OSA: a systemic review and meta-analysis. *Eur Arch Otorhinolaryngol.* 2016;273(9):2329-2333.
13. Butterfield K, Marks P, McLean L, Newton J. Linear and volumetric airway changes after maxillomandibular advancement for obstructive sleep apnea. *J Oral Maxillofac Surg.* 2015;73(6):1133-1142.
14. Boyd SB, Walters AS, Song Y, Wang L. Comparative effectiveness of maxillomandibular advancement and uvulopalatopharyngoplasty for the treatment of moderate to severe obstructive sleep apnea. *J Oral Maxillofac Surg*. 2013;71(4):743-751.
15. Hsia J, Camacho M, Capasso R. Snoring exclusively during nasal breathing: a newly described respiratory pattern during sleep. *Sleep Breath*. 2014;18(1):159-164.
16. Georgalas C. The role of the nose in snoring and obstructive sleep apnoea: an update. *Eur Arch Otorhinolaryngol*. 2011;268(9):1365-1373.

Kathelijne Delsupehe, M.D.,
Department of Otolaryngology
AZ Delta
Wilgenstraat 2
8800 Roeselare, Belgium
E-mail: lieve.delsupehe@azdelta.be