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MISCELLANEOUS

Drug-induced sleep endoscopy changes snoring management plan very significantly compared to standard clinical evaluation

Karen Pilaete · Joris De Medts · Kathelijne Godelieve Delsupehe

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Abstract Drug-induced sleep endoscopy (DISE) is a new tool in the work-up of patients with sleep-disordered breathing (SDB). We assessed the impact of DISE on the treatment plan of snoring patients. This is a single institution prospective longitudinal clinical trial. The setting is a private teaching hospital. A consecutive series of 100 snoring patients prospectively underwent a standardised questionnaire, clinical examination, rhinomanometry, allergy skin prick testing, DISE and polysomnography. Management plan before and after DISE evaluation was compared. In 61 patients (excluding 16 patients sent for continuous positive airway pressure, three patients refused sleep endoscopy and 20 were lost to follow-up), we compared the treatment plans. DISE showed single level airway collapse in 13 and multilevel collapse in 48 patients. The site of flutter did not add additional information as compared to the pattern and the location of the collapse. After DISE, the initial management plan changed in 41 % of patients irrespective of the type of initial management plan. The only somewhat accurate initial treatment plan was uvulopalatopharyngoplasty (unchanged in 11/13 patients). Excluding moderate to severe obstructive sleep apnea patients DISE is an indispensable tool in treatment decision in all SDB patients. We suggest to simplify the protocol for DISE reporting.

K. Pilaete
ENT Department, University Hospitals of Leuven, Leuven, Belgium

J. De Medts · K. G. Delsupehe (✉)
ENT Department, H.-Hart Ziekenhuis Roeselare-Menen, Wilgenstraat 2, 8800 Roeselare, Belgium
e-mail: baert.delsupehe@skynet.be

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Abbreviations

AHI	Apnea Hypopnea Index
BIS	Bispectral index monitoring
CPAP	Continuous positive airway pressure therapy
DISE	Drug-induced sleep endoscopy
MAD	Mandibular advancement device
OSA	Obstructive sleep apnea
PSG	Polysomnography
RF	Radiofrequency
SDB	Sleep-disordered breathing
TCI	Target controlled infusion
UPPP	Uvulopalatopharyngoplasty

Introduction

The optimal treatment in patients with sleep-disordered breathing (SDB) with non-apneic snoring or mild obstructive sleep apnea (OSA) (apnoea–hypopnoea index (AHI) <20) is still debated. A number of upper airway surgical procedures and devices have been developed over the past 30 years, all trying to improve the upper airway patency. The effects of these treatments are difficult to predict and snoring may reoccur long term [1, 2]. To improve treatment selection, a better assessment of the dynamic upper airway anatomy during sleep in patients with SDB is needed. Standard evaluation is still routine clinical assessment. The Müller manoeuvre to locate the site of upper airway collapse has failed to reliably predict

surgical success [3]. Plain film cephalometry and CT-scan only provide information about the bony structures. Furthermore, they do not offer insight on soft tissue collapse and are performed in the awake patient. Sleep MRI is an upcoming promising modality, but the accessibility and the cost make it less attractive.

Drug-induced sleep endoscopy (DISE) allows direct visualization of the site or sites of obstruction in a sleeping patient [4]. Berry et al. [5] already proved the validity of sleep endoscopy with target controlled infusion of sedation (TCI), reducing the chance of excessive muscle relaxation and hence false-positive obstructive events. Hamans et al. [6] showed that sleep endoscopy is a safe procedure when performed in the operating room with TCI of propofol in the presence of an experienced anaesthesiologist.

With this study we evaluated the added value of DISE in the multidisciplinary management of snoring patients. In particular, our goal was to prove whether drug-induced sleep endoscopy (DISE) really changed the initial treatment plan based on standard clinical evaluation.

Materials and methods

Subjects

A consecutive group of 100 patients who presented at our clinic with sleep-disordered breathing (SDB) from May 20 2011 until May 12 2012 were included in our study. This study was approved by the institutional review Board (Medical Ethical Committee) of our institution. All patients gave informed consent prior to inclusion in the study.

Patient evaluation and data collection

At first presentation, a standardised clinical investigation (with nasal endoscopy, scoring of Friedman tongue position and tonsil size, evaluation of dental occlusion/chin position and laryngoscopy to evaluate the larynx, epiglottis, tongue base and tongue tonsil) was completed. Patients (with or without their partner) filled out a questionnaire that included the patients characteristics (BMI, smoking, alcohol use, sleeping medication, sleep steadiness of partner), the snoring intensity (from 0: no snoring at all to 10: partner always sleeps in another room), a snoring score on a visual analogue scale from 0 to 10 (VAS scale), the severity of snoring (frequency, time and loudness of snoring) and the sleepiness of the patient in 8 different circumstances (Epworth sleepiness scale) [7]. To exclude allergy, skin prick testing was done and nasal resistance was measured with rhinomanometry. Based on this clinical history and standardised examination, one of the two principal investigators (LD, JDM) proposed a treatment option. Possible treatment options were nasal surgery, a palatal procedure (UPPP or radiofrequency (RF) of the palate), a tongue base procedure (RF of the tongue base or hyoid suspension), a mandibular advancement device (MAD) and continuous positive airway pressure (CPAP) treatment. A polysomnography and sleep endoscopy were then planned in every patient. If polysomnography showed an AHI >20, patients were considered for CPAP. If this was known on beforehand, further sleep endoscopy was not performed.

Initial treatment modality selection

Given the high number of parameters evaluated there are no fixed rules to select the initial treatment plan. However, general rules for selecting the four major treatment options were as follows: RF palate for important palatal webbing and/or large uvula; RF tongue base was added when in addition Friedman tongue position >3 and moderate or large tongue base; MAD with isolated Friedman tongue position >3 and moderate or large tongue base or with retrognathia (and sufficient denture); UPPP is suggested with tonsil size >3 and large palate and uvula size. These rules apply only for patients with BMI <32; If BMI >32 patients were not selected for surgery. In obese patients either CPAP or MAD was suggested.

DISE: Sleep endoscopy procedure

Sleep endoscopy was performed in the operating room with target controlled infusion (TCI) of propofol. The exam starts by administration of 1 mg midazolam in bolus. Subsequently propofol is administrated by an anesthesiologist by target controlled infusion (TCI) using bispectral analysis (BIS) monitoring [8, 9]. The following parameters were recorded systematically in all patients. When a snoring noise is generated, the location of obstruction was specified as flutter or collapse according to the VOTE classification [10]. Collapse was further defined as monolevel (palatal/oropharyngeal or tongue base/epiglottis) or multilevel (combination of palatal/oropharyngeal and tongue base/epiglottis) collapse. The pattern of collapse was further categorised as antero-posterior, latero-lateral or circular. Flutter was graded as present or absent and the location was given (palatal/oropharyngeal/tongue base/epiglottis). A careful mandibular advancement manoeuvre (advancing the mandibula only 0.5–0.6 cm) (the Esmarch manoeuvre) was performed in every patient, to predict the effect of a MAD treatment. To minimise inter-rater variability all DISE were reported by either one of two ENT attending physicians (LD and JDM) and checked separately by either one of two residents (KP and Jeroen Meulemans). After their independent evaluation, the attending and resident performing the procedure completed the DISE reporting together.

After confronting the DISE report with the initial evaluation (including clinical evaluation with symptoms and signs, questionnaires, polysomnography), a final treatment plan was proposed to the patients after multidisciplinary discussion.

Proposed treatment after DISE

RF palate was suggested when DISE revealed unilevel palatal collapse; RFA palate + tongue base with multilevel collapse (palate and tongue base). MAD was suggested in unilevel tongue base or epiglottis collapse, in lateral pharyngeal collapse and in complete circular palatal collapse; UPPP in unilevel oropharyngeal collapse. The Esmarch manoeuvre was taken into account to predict the success of the MAD treatment.

Results

Demographic data and patient flow

A consecutive series of 100 patients presenting over the 12 months trial period prospectively underwent a standardised questionnaire, clinical examination, rhinomanometry, allergy skin prick testing, DISE and polysomnography (PSG). Of those patients, eventually 72 had a full work-up, and 61 received a treatment plan before and after DISE (Fig. 1). Patients baseline characteristics, signs, rhinomanometry and allergy test results and snoring scores are listed in Tables 1, 2 and 3. Comparison of the baseline characteristics between the initial group of 100 and the remaining group of 72 and eventually 61, shows no statistical difference except (by definition) for the AHI (since patients with a AHI >20 were excluded from our analysis).

Results of DISE

DISE results are shown in Tables 4, 5. The majority of patients (78.7 %) had multi-segmental airway collapse on DISE whereas the remainder had only single level collapse. Single level collapse was observed at the palatal/oropharyngeal level in 14.7 % and at tongue base/epiglottis level in 6.6 %. Overall palatal collapse was present in 93.4 %, tongue base in 78.7 %, epiglottis in 49.2 % and oropharyngeal collapse in 23 %. The site of flutter did not differ from the site of collapse. In terms of the pattern of collapse, we observed circular oropharyngeal collapse in 10/14 patients and latero-lateral collapse in 4/14 patients. In our series, the type of collapse at the epiglottic levels was

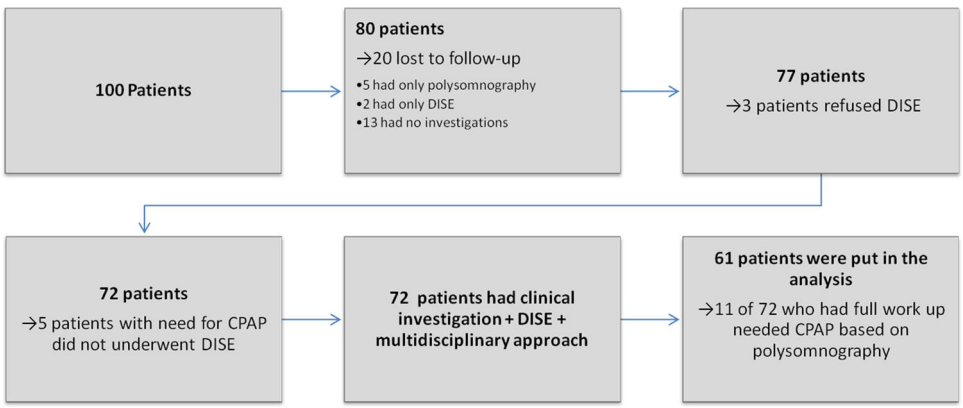

Fig. 1 Patient flow chart

Table 1 Baseline characteristics of the patients

	$n = 100$	Total population	$n = 72$	Patients with full work-up	$n = 61$	Patients with AHI >20 excluded
Gender	($n = 100$)		($n = 72$)		($n = 61$)	
Male		77 (77 %)		57 (79 %)		47 (77 %)
Age (median + range)	($n = 100$)	46.5 (17–74)	($n = 72$)	46 (17–67)	($n = 61$)	45.2 (17–67)
BMI (median + range)	($n = 100$)	19.1 (27.3–41)	($n = 72$)	26.8 (19.0–34.8)	($n = 61$)	26.2 (19.1–33.1)
Smoking	($n = 97$)	26 (26.8 %)	($n = 70$)	18 (25.7 %)	($n = 60$)	17 (28.3 %)
Alcohol	($n = 96$)					
During the day		54 (56.3 %)	($n = 70$)	41 (58.6 %)	($n = 60$)	34 (56.6 %)
In the evening		57 (59.4 %)		47 (67.1 %)		41 (68.3 %)
Sleep medication	($n = 94$)	13 (13.8 %)	($n = 68$)	6 (8.8 %)	($n = 58$)	5 (8.6 %)

Table 2 Patients signs at dedicated baseline physical examination

Signs	$n = 100$	Total population	$n = 72$	Full work-up	$n = 61$	AHI > 20 excluded
Septal deviation	($n = 100$)		($n = 72$)		($n = 61$)	
No deviation		22 (22 %)		18 (25 %)		17 (27.9 %)
Slight deviation		48 (48 %)		32 (44.4 %)		26 (42.6 %)
Strong deviation		30 (30 %)		22 (30.6 %)		18 (29.5 %)
Nasal turbinate hypertrophy	($n = 100$)		($n = 72$)		($n = 61$)	
None		31 (31 %)		20 (27.8 %)		15 (24.6 %)
Slight		54 (54 %)		40 (55.6 %)		34 (55.7 %)
Strong		15 (15 %)		12 (16.7 %)		12 (19.7 %)
Friedman tongue position	($n = 99$)		($n = 71$)		($n = 61$)	
1		8 (8.1 %)		7 (9.8 %)		6 (9.8 %)
2		21 (21.2 %)		15 (21.1 %)		14 (23.0 %)
3		36 (36.3 %)		25 (35.2 %)		23 (37.7 %)
4		34 (34.3 %)		24 (33.8 %)		18 (29.5 %)
Tonsil size	($n = 99$)		($n = 71$)		($n = 61$)	
0		27 (27.3 %)		22 (31. %)		18 (29.5 %)
1		42 (42.4 %)		25 (35.2 %)		22 (36.1 %)
2		24 (24.2 %)		18 (25.4 %)		15 (24.6 %)
3		6 (6.1 %)		6 (8.5 %)		6 (9.8 %)
Webbing	($n = 97$)		($n = 71$)		($n = 60$)	
Normal		68 (70.1 %)		51 (71.8 %)		41 (68.3 %)
Moderate		13 (13.4 %)		10 (14.1 %)		10 (1.6 %)
Strong		14 (14.1 %)		10 (14.1 %)		9 (15 %)
Status after UPPP		2 (2.1 %)		0 (0 %)		0 (0 %)
Uvula	($n = 96$)		($n = 70$)		($n = 59$)	
Normal or resected		89 (92.7 %)		65 (92.8 %)		54 (91.5 %)
Moderate		2 (2.1 %)		1 (1.4 %)		1 (1.7 %)
Large		5 (5.2 %)		4 (5.7 %)		4 (6.8 %)
Dental status	($n = 100$)		($n = 72$)		($n = 61$)	
Edentate		19 (19 %)		15 (20.8 %)		15 (24.6 %)
Normal		59 (59 %)		42 (58.3 %)		34 (55.7 %)
Incomplete denture		22 (22 %)		15 (20.8 %)		12 (19.7 %)
Retrognathia	($n = 100$)		($n = 72$)		($n = 61$)	
No		76 (76 %)		56 (77.8 %)		50 (82.0 %)
Yes		23 (23 %)		15 (20.8 %)		10 (16.4 %)
Prognathia		1 (1 %)		1 (1.4 %)		1 (1.6 %)
Epiglottis	($n = 100$)		($n = 72$)		($n = 61$)	
Normal		87 (87 %)		64 (88.9 %)		55 (90.1 %))
Curly		11(11 %)		7 (9.7 %)		5 (8.2 %)
Large		2 (2 %)		1 (1.4 %)		1 (1.6 %)
Tongue base	($n = 100$)		($n = 72$)		($n = 61$)	
Normal		48 (48 %)		36 (50.0 %)		31 (50.8 %)
Moderate		28 (28 %)		19 (26.4 %)		18 (29.5 %)
Large		24 (24 %)		17 (23.6 %)		12 (19.7 %)
Tongue tonsil	($n = 100$)		($n = 72$)		($n = 61$)	
Normal		74 (74 %)		54 (75.0 %)		45 (73.8 %)
Moderate		18 (18 %)		12 (16.7 %)		10 (16.7 %)
Large		8 (8 %)		6 (8.3 %)		6 (9.8 %)

Table 3 Patients rhinomanometry and allergy tests and snoring scores

Symptoms	$n = 100$	Total population	$n = 72$	Patients with full work-up	$n = 61$	Patients with AHI > excluded
Rhinomanometry before decongestion	($n = 97$)		($n = 71$)		($n = 60$)	
Optimal		13 (13.4 %)		5 (7.0 %)		5 (8.3 %)
Normal		35 (36.1 %)		30 (42.3 %)		26 (43.3 %)
Suboptimal		36 (37.1 %)		25 (35.2 %)		19 (31.7 %)
Severe obstruction		13 (13.4 %)		11 (15.5 %)		10 (16.7 %)
Rhinomanometry after decongestion	($n = 97$)		($n = 71$)		($n = 60$)	
Optimal		56 (57.7 %)		41 (57.7 %)		36 (60 %)
Normal		26 (26.8 %)		20 (28.2 %)		15 (25 %)
Suboptimal		11 (11.3 %)		7 (9.9 %)		6 (10 %)
Severe obstruction		4 (4.1 %)		3 (4.2 %)		3 (5.0 %)
Allergy	($n = 96$)	32 (33.3 %)	($n = 71$)	26 (36.6 %)	($n = 60$)	23 (38.3 %)
Mite		25 (26.0 %)		21 (29.6 %)		18 (30.0 %)
Grasses		17 (17.7 %)		10 (14.1 %)		10 (16.6 %)
Spring trees		10 (10.4 %)		7 (9.9 %)		7 (11.7 %)
Summer herbs		1 (1.0 %)		1 (1.4 %)		1 (1.7 %)
Animals		10 (10.4 %)		8 (11.3 %)		7 (11.7 %)
Fungi		0 (0.0 %)		0 (0.0 %)		0 (0.0 %)***

		Median (range)		Median (range)		Median (range)
Snoring intensity	($n = 93$)	8 (3–10)	($n = 68$)	7.8 (3–10)	($n = 58$)	7.6 (3–10)
Sleepiness	($n = 95$)	8 (1–21)	($n = 69$)	8.6 (1–21)	($n = 59$)	8.6 (1–21)
Snoring score	($n = 90$)	7.6 (3–10)	($n = 67$)	7.5 (3–10)	($n = 57$)	7.3 (3–10)
AHI	($n = 85$)	13.7 (0.2–73.8)	($n = 70$)	12.1 (0.2–65.9)	($n = 59$)	7.6 (0.2–19)

Table 4 DISE results: unilevel

Anatomic Site	Flutter	Collapse					
		Antero-posterior		Latero-lateral		Circular	
		Part	Comp	Part	Comp	Part	Comp
Palatal	9	3	1	0	0	0	5
Oropharyngeal	0			0	0		
Tongue base	2	0	2				
Epiglottis	2	2	0	0	0		

always antero-posterior. Latero-lateral collapse of the epiglottis was not observed. When performing a careful Esmarch manoeuvre (0.5 tot 0.6 cm), flutter or collapse ceased in 48/61 patients. No complications of DISE examination were observed and no patients required urgent airway intervention or intubation.

Treatment before and after work-up with sleep endoscopy

The proposed treatment options at the first consultation and the eventual treatment plan after sleep endoscopy, polysomnography and multidisciplinary discussion were

Table 5 DISE results: multilevel

		Flutter	Collapse								
			Antero-posterior			Latero-lateral			Circular		
			Part	Comp	Total	Part	Comp	Total	Part	Comp	Total
Palatal/epiglottis (n=2)	Palatal	2	0	1	1	0	0	0	0	1	1
	Epiglottis	0	2	0	2	0	0	0			
Palatal/tongue base (n=13)	Palatal	13	4	6	10	0	0	0	1	2	3
	Tongue base	4	6	7	13						
Palatal/epiglottis/tongue base (n=19)	Palatal	19	4	13	17	0	0	0	1	1	2
	Epiglottis	16	17	2	19						
	Tongue base	2	8	11	19						
Palatal/Oropharyngeal/ tongue base (n=7)	Palatal	7	1	1	2	0	1	1	1	3	4
	Oropharyngeal	0				0	2	2	3	2	5
	Tongue base	4	3	4	7						
Palatal/oropharyngeal/ tongue base/epiglottis (n=7)	Palatal	7	4	3	7	0	0	0	0	0	0
	Oropharyngeal	0				2	0	2	2	3	5
	Tongue base	2	1	6	7	0	0	0			
	Epiglottis	5	2	5	7						

analysed. Data were obtained in 72 patients, of whom 11 were referred for continuous positive airway pressure therapy (CPAP). The remaining 61 patients were analysed. Figure 2 shows the treatment before and after DISE (and polysomnography) only for the four most frequent proposed treatment options at first consultation. In 41 % of cases, the treatment plan changed after DISE.

The only somewhat accurate initial treatment plan was uvulopalatopharyngoplasty (UPPP) (unchanged in 11/13 patients). MAD changed in 8 out of 19 patients, radiofrequency of the palate in 6 out of 12 patients and radiofrequency of palate and tongue base in 5 out of eleven patients.

Discussion

Our study shows that DISE has a very significant impact on the treatment management plan as compared to standard clinical evaluation. In addition, based on our DISE results, we suggest to adapt the reporting of DISE according to the VOTE classification.

With this study, we show for the first time the extra added value of DISE in SDB patients with snoring and mild OSA as compared to clinical decision-making. We excluded moderate to severe OSA patients. We performed sleep endoscopy using intravenous bolus of midazolam followed by a target controlled infusion (TCI) of propofol. Berry et al. [5] already proved the validity of sleep endoscopy with TCI of propofol in reducing the chance of excessive muscle relaxation and by consequence false-positive obstructive events. In addition, BIS monitoring was used in all patients. The addition of BIS monitoring allows more accurate assessment of sedation induced snoring. The BIS controlled degree of sedation enables to approach the levels of depth of natural sleep as close as possible [8].

We observed a change in 41 % of our initial treatment proposal. The only somewhat accurate initial treatment plan was UPPP. We speculate that this result from the fact

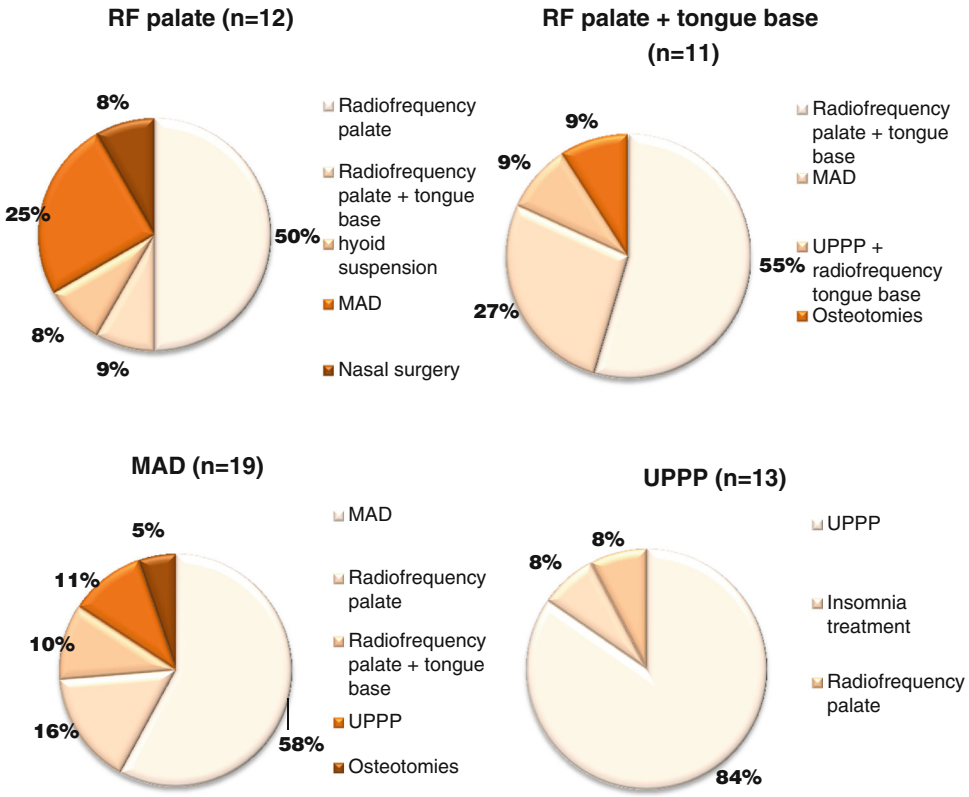

Fig. 2 Treatment plan before (on top of pie) and after DISE (pie chart). Note to Fig. 2: This table compares the initial treatment plan (stated above the pie charts) with the final proposed plan after DISE (and polysomnography) (in the pie charts) of the most common proposed treatments (55/61 patients)

that the clinical evaluation of the palate and oropharynx with tonsils is more accurate as compared to the evaluation of the tongue base and, therefore, correlates better with the functional impact during snoring. In similar recently performed studies, Gillespie et al. even showed an alteration of the surgical plan in 61 % and Eichler et al. in 64 % (up to 78,4 % if they included patients with MAD) [11, 12]. These results uniformly prove the extra added value of sleep endoscopy. In our study, the most frequent site of collapse was the palate in 93.4 % of cases, followed by the tongue base in 78.7 %, the epiglottis in 49.2 % and oropharyngeal collapse in 23 %. This is in line with the recent study of Eichler, which showed an obstruction of, respectively, 93.8 %, 76.3 % and 32 % for the soft palate, tongue base and epiglottis [11]. Bachar et al. [13] found in a population of exclusively OSA patients an obstruction of the uvulopalatine in 89 %, followed by the tongue base, hypopharynx and larynx in 33 % each and nose in 21 %. 72 % of their patients had multiple obstructions, as is also shown in our study where 78.7 % have multilevel collapse. Although yielding very similar results, our study is the only study where only non-apneic and mild OSA patients were included both for DISE reporting and change of management plan.

We verified whether a correlation existed between any parameter of our standardised clinical examination and the initial treatment plan. We also searched for a relationship between BMI and treatment. To our surprise, it was very difficult to find a direct relationships between separate (or a combination of) clinical findings or BMI and the initial proposed treatment plan. This only underscores the current lack of clear treatment selection guidelines and the need for additional tools such as DISE to facilitate and objectify treatment planning.

We performed a mandibular advancement manoeuvre during sleep endoscopy (Esmarch) in every patient, to predict the outcome of therapy with an MAD. This manoeuvre was executed to the exact same extent as the effect of the MAD (i.e. only advancing 0.5–0.6 cm). During the manoeuvre, we reevaluated the whole upper airway for obstructions. Hereby, flutter and/or collapse of the upper airway disappeared in 48 out of 61 patients. Vanderveken et al. recently described a simulation bite approach for the prediction of the outcome of treatment of obstructive sleep apnea with mandibular repositioning appliances [12, 14]. Future use of this approach may predict the success of MAD treatment even better.

Our study has limitations. The high number of parameters recorded on the first evaluation complicated the choice of the initial treatment plan. In addition, we cannot exclude that the addition of a multidisciplinary team discussion including other ENT physicians, a pulmonologist, maxillofacial surgeon and dental surgeon after DISE altered the final treatment plan.

Table 6 Proposal for modification of DISE classification: from VOTE to VOLTE?

Structure	Flutter	Collapse					
		Antero-posterior		Latero-lateral		Circular	
		Part	Comp	Part	Comp	Part	Comp
Palatal							
Oropharyngeal							
Tongue base							
Epiglottis							

Structure	Collapse					
	Antero-posterior		Latero-lateral		Circular	
	Part	Comp	Part	Comp	Part	Comp
Velum/ Palatal						
Oropharyngeal: palatine tonsils						
Lateral pharyngeal walls						
Tongue base						
Epiglottis						

Hitherto, DISE reporting is not well standardised. We used the VOTE classification for reporting. In our results, the site of flutter never differed from the site of collapse. Therefore, recording both the site of flutter and the site of collapse seems of little value. In addition, we observed circular oropharyngeal collapse at the level of lateral pharyngeal wall which is not included in the VOTE table. On the other hand, we did not encounter latero-lateral collapse of the epiglottis included in the VOTE system. The VOTE classification consists of four different structure levels. The second oropharyngeal level combines the palatine tonsils and the lateral pharyngeal wall [9]. We agree with Vanderveken OM (personal communication) that both levels should be recorded separately since it may have therapeutic implications [9]. In this case, we could extend the VOTE system to five structure levels (VO(L)TE). Therefore, we suggest to modify the DISE reporting accordingly (Table 6).

From a practical therapeutic point of view, we speculate that the distinction between multi- and uni-level collapse and the site of collapse is the most important finding of the DISE. Further investigation is needed to clarify the therapeutic consequence of the pattern of collapse. Recently Koutsourelakis described in a population of OSA patients that completely circumferential collapse of the velum and completely antero-posterior collapse at tongue base or epiglottis were negative predictors for the success of the surgical interventions they studied [15]. We believe that DISE reporting needs to be simplified and standardised further to become a uniform and simple tool, hereby, improving inter- and intra-rater reliability and wider acceptance.

Finally, we confirm that sleep endoscopy is a safe procedure when performed in the operating room in the presence of an experienced anesthesiologist [6].

Further investigation is needed to verify whether sleep endoscopy does not only influences the treatment plan, but also leads to better treatment results. To evaluate treatment results, prospective studies should be performed randomising patients to treatments with or without treatment DISE evaluation. Given the safety and the already widely acceptance and use of DISE in referral centres it is unlikely that these studies will ever be performed. Perhaps studies comparing DISE with sleep MRI will further elucidate the validity of DISE in the future.

Conclusion

We showed that sleep endoscopy clearly has an extra added value in the evaluation and treatment selection of patients with sleep-disordered breathing excluding patients with obstructive sleep apnoea. We suggest to simplify and further standardise DISE reporting.

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Conflict of interest All authors declare that they have no conflicts of interest with regard to this manuscript.

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