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HEAD AND NECK

Relationship between level CPAP titration, anthropometric variables, and drug-induced sleep endoscopy DISE

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Abstract

Introduction Subjects with palatal obstruction alone vs. multilevel obstruction on DISE had better outcomes after palate surgery. We asked ourselves if the therapeutic level positive airway pressure (PAP) titration could predict the level of airway obstruction and its complexity.

Purpose The aim of this study was to identify possible relationships between therapeutic level of positive airway pressure initial titration and levels of collapse in drug-induced sleep endoscopy (DISE). A secondary objective was to establish the relationship the other variables and DISE.

Methods We analyzed retrospective clinical histories between March 2020 to March 2022 of 37 patients with polysomnography or cardiorespiratory polygraphy studies and PAP initial titration who were taken to drug-induced sleep endoscopy. Sleep study data, anthropometric variables, and patterns of airway collapse during DISE were analyzed with PAP initial titration levels.

Results Most of the patients with complex collapse had concentric velum collapse ($p < 0.006$). A significant association was found between the apnea–hypopnea index (AHI) and oropharyngeal collapse; ($p < 0.0030$) and finally we demonstrated relationship between neck circumference and gender with epiglottis collapse ($p < 0.046$), ($p < 0.037$), respectively.

Conclusions Our findings show a strong relationship between that complex collapses and concentric velum collapse; patients with greater oropharyngeal collapse have a higher mean AHI. Patients without epiglottic collapse have a higher mean neck circumference. An association between mean pressure initial titration and complex collapse could not be established.

Keywords Obstructive sleep apnea · Epiglottic collapse · Continuous positive airway pressure · Positive airway pressure · Drug-induced sleep endoscopy · Automatic titration

Introduction

Obstructive sleep apnea (OSA) is a frequent sleep disorder characterized by recurrent upper airway collapse during the sleep producing impact on quality of life, with consequences,

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such as diminished oxygen saturation levels, and excessive sleepiness during the day [1–3]. The assessment of patients for snoring and OSA includes a comprehensive sleep history, some predictive scales, physical examination, diagnostic sleep study and ideally, positive airway pressure titration as a diagnostic and therapeutic tool [4]. There are different treatments, such as positive airway pressure (PAP), mandibular advancement devices (MAD), surgical approaches and positional therapy, being the most important aspect the customized evaluation for an adequate response and high adherence to improving treatment outcome [5].

For this purpose, drug-induced sleep endoscopy (DISE) described by Pringle and Croft In the 1990s, is a very useful tool that allows dynamic evaluation of the sites of disturbance and collapse and evaluate treatment alternatives, using a flexible nasopharyngoscope to visualize the upper airway under sedation similar to natural sleep [6–8].

Sedation can be induced with a variety of drugs. Midazolam and propofol are the most common drugs, either as a single agent or combined among them and also with others, such as remifentanil or ketamine [9]. An excellent option for inducing sedation for the endoscopic assessment is dexmedetomidine, which is a selective α2-receptor agonist that inhibits the locus coeruleus, mainly a noradrenergic nucleus in the brain stem. It has sedative and anxiolytic properties and is known for its analgesic potential due to a reduction of the sympathetic tone. Dexmedetomidine induces from minimal to deep sedation, depending on the dose and concentration of the drug. The patient can be easily roused to a lucent state and even though is not a physiological sleep, induces a state very similar to natural sleep [10].

It is very important to identify the obstruction site, for example, palatal obstruction alone had better outcomes after palate surgery versus multilevel obstruction on DISE [11], and the resolution of airway obstruction with manual mandibular advancement, such as the Esmarch maneuver under sedation, is associated with better outcomes with treatment using MAD [12].

Recently, phenotypes have been described for the successful response to MAD based on DISE findings, describing an anatomical phenotype observed in DISE with a better response to MAD with collapse of the base of the tongue occurs and the response is less favorable to the MAD with complete concentric collapse at the level of the palate and complete laterolateral oropharyngeal collapse [13].

Another point to be considered is the epiglottis, a laryngeal structure that was ignored in the early years on procedures to treat obstructive breathing disorders. Nevertheless, recent studies have shown that it plays a significant role, either on its own or combined with other pharyngeal structures [14]. The introduction of DISE has shown that obstruction, either partial or complete, often occurs at the epiglottis in 10–40% of patients, and more frequently anteroposterior collapse or even a greater collapse with the use of PAP was reported by patients such as greater sensation of dyspnea with the use of positive airway pressure [14–16].

The standard treatment of moderate-to-severe OSA is continuous positive airway pressure (CPAP), which eliminates obstructive respiratory events and patents the upper airway during sleep, it is necessary to determine the optimal pressure at which obstructive respiratory events are eliminated, to start treatment with positive pressure this initial titration can be done at home or in a sleep lab, the gold standard is to do it at a sleep laboratory; however, costs, time, and availability have allowed home titration with auto-adjusting positive pressure devices (APAP) to be an alternative tool to establish initial treatment pressure [17]. In addition, different studies have found no statistically significant difference between auto-adjusting positive airway pressure (APAP) titration at home or manual CPAP titration in a sleep laboratory [17, 18].

Finally, the aim of this study was to identify possible relationships between therapeutic level of PAP initial titration and levels of collapse in drug-induced sleep endoscopy.

Methods

Study design

We analyzed retrospective data from 37 OSA patients who participated in sleep studies from March of 2020 until March of 2022. Participants were recruited at sleep clinics, Ronquido Monterrey and ISSSTE Constitución in Monterrey, Mexico. All patients had had sleep tests either type 2 or type 3, according to the American Academy of Sleep Medicine (AASM). PAP titration level was established with Bilevel-AirCurve™ 10 VAuto or AirSense™ 10 AutoSet™ (ResMed) during 3–6 days, for PAP initial titration, p95 and mean pressure data were obtained. All patients were screened and excluded if they had incomplete data in the clinical history.

The sedation started using an infusion pump of dexmedetomidine (Precedex® Abbott Laboratories, United States) with a dose of 1 mcg × kg of weight. Conscious sedation was achieved in about 20 min, the response to verbal stimuli decreased and the patient initiated snoring and apneas. Nasoendoscopy was performed without the use of topical anesthetic or vasoconstrictor in three different positions: supine, left lateral, and right lateral.

The pattern of obstruction at the different levels was described, according to VOTE classification [19]. We defined complex collapse as those patients with collapse in two or more anatomic areas. A descriptive analysis of the qualitative variables was carried out. For the quantitative variables, measures of central tendency and dispersion

were calculated and reported according to their normality (normality was tested with the Shapiro–Wilk test). For bivariate analysis, cross-frequency tables of the different qualitative variables were made for the differences for the types of collapses (veil, oropharyngeal, tongue, epiglottis). The measures of central tendency of the quantitative variables were reported according to the anatomical location of the collapse. In addition, we divided the collapse into two groups, patients with one level of collapse, called single collapse, or complex collapse if they had more than one level of obstruction.

To evaluate associations between the different anatomical locations and the qualitative variables, the chi-square test of independence was performed. To evaluate associations between the different anatomical locations of the collapse, and the quantitative variables, Anova was performed. For variables with normal distribution, in case of finding significant differences, post hoc tests (Tukey's test) were performed. For non-parametric distribution variables, the Kruskal–Wallis test was performed and in the case of finding significant differences between the categories, the Wilcoxon test was used.

Results

The study population consisted of 37 patients, 67% were men and 32% women. The mean age was 47.2 years, mean perimeter cervical was 40.3 cm, AHI mean was 25.5/h and the mean PAP initial titration level was 7.6 cmH_20. These variables are shown in Table 1.

The masculine gender was not associated with epiglottic collapse ($p < 0.0037$) and patients without epiglottic collapse had a higher neck circumference ($p < 0.046$).

The collapse of the soft palate was the most frequent collapse in 91%, followed by the oropharynx collapse in 64%, only 32% of the patients presented epiglottic collapse, the data are shown in Table 2.

Table 1 Patient characteristics

Variables	Mean ± SD	Range
Females (*n*, %)	12 (32%)	–
Males (*n*, %)	25 (67%)	–
Neck circumference	40.3 ± 4.5	31.0–49.0
BMI, kg/m^2	24.99 ± 3.16	22.0–35.0
Age, years	47.2 ± 9.8	30.0–72.0
AHI, events/h	25.51 ± 19.7	1.70–82
Mean APAP pressure	7.67 ± 2.71	4.0–17.0
P95% APAP pressure	9.57 ± 2.83	4.3–16.4

Table 2 Distribution of obstruction (%) using VOTE classification system

Pattern	% (#)
Velum	91% (34)
Concentric	18
Antero-posterior	14
Lateral	2
Oropharynx—lateral	64% (24)
*1	8
*2	16
Tongue—antero-posterior	59% (22)
*1	14
*2	8
Epiglottis	32% (12)
Antero-posterior	9
Lateral	3

*Degree vote classification by Kezirian

Bivariate analysis of associations

Most patients had more than one level of collapse, it was observed that the complex collapse was present in 89% of the cases, Patients with complex collapse had more velum collapse ($p < 0.003$), and this complex pattern is more associated with concentric type collapse of velum ($p < 0.0064$), the data are shown in Table 3.

Patients with complete oropharyngeal collapse (type 2) were associated with a significantly higher mean AHI compared to absence of oropharyngeal collapse (type 0) ($p < 0.0030$), Fig. 1.

Mean titration pressure was 7.3 cmH_20 and mean titration P95 was 9.5cmH20, no significant association was found between initial level PAP titration and the different types of collapses, Fig. 2.

Mean PAP pressure for single type of collapse was 8.3 cmH_20 (± 2.78) and for complex collapse was 7.6 cmH_20 (± 2.74) (p value 0.71), there are no differences between the mean of median pressure in patients with single vs. complex collapse, also mean percentile 95% pressure for single collapse was 10.8 cmH_20 (± 2.5) and complex collapse 9.3 cmH_20 (± 2.86) (*p* value 0.3431). There are no differences between the mean of percentile 95% pressure.

Table 3 DISE findings correlation between complex and single collapse

Types of collapse	
0 (single)	4 (11%)
1 (complex)	33 (89%)
Velum concentric	18
0 (single)	0 (0%)
1 (complex)	18 (100%)

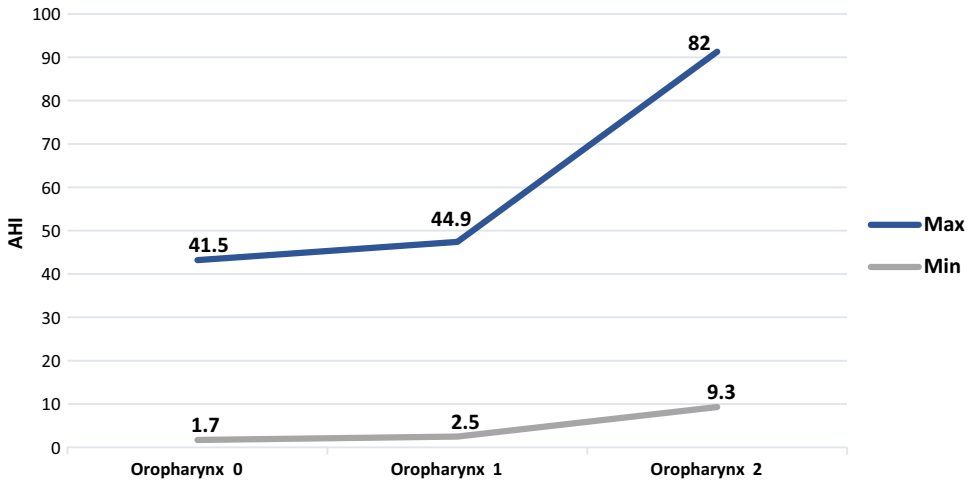

Fig. 1 Correlation between levels oropharyngeal collapse in DISE and AHI

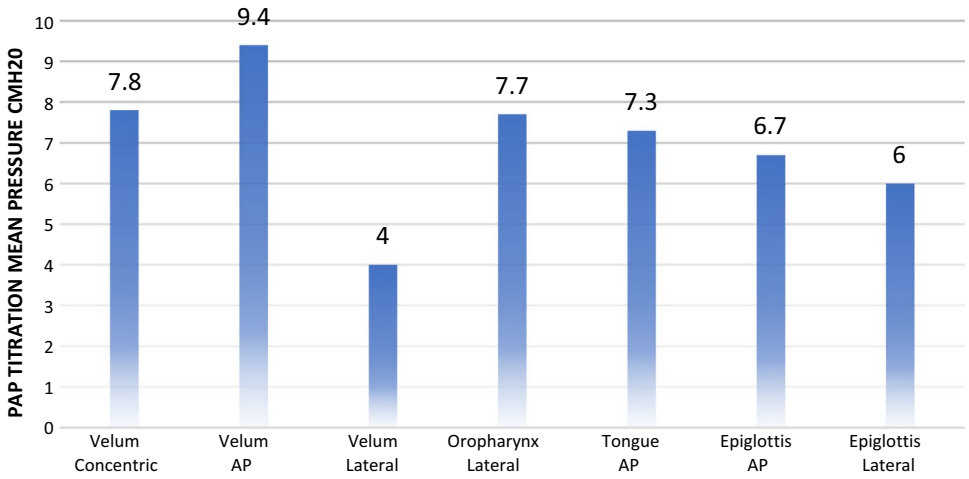

Fig. 2 Positive airway pressure titration and collapse levels in DISE. *AP* Anteroposterior

An association between pressure initial titration and complex collapse could not be established.

Discussion

Our study shows associations between anthropometric and clinics variables with DISE findings.

We found a strong relationship between AHI and oropharyngeal collapse and complex collapse more frequently at velum. However, it was not possible to establish any association between the positive airway pressure initial titration and the types of collapse during the DISE.

DISE is a useful tool to identifying the sites of upper airway obstruction, it is not only important for a diagnosis but also as a guidance to precise treatment and is a paramount step for surgical success [20]. Besides the role of DISE has been proposed as a tool to elucidate the possible mechanisms to treatment failure with positive airway pressure [20, 21].

Most common findings during DISE are retropalatal collapse [22]. Our results indicate that complex collapses (one more than one level) had more concentric velum collapse. This collapse pattern has important considerations: there is a higher risk of treatment failure in case of upper airway stimulation or the use of MAD [13, 23], this failure was also associated with a higher residual AHI postoperative and with a significantly higher PAP titration level [24, 25]. This last association was not found in our study.

Our findings show a strong relationship between patients with oropharyngeal collapse degree 2 have higher mean AHI that oropharyngeal collapse degree 1; previously demonstrated by Koo et al., who found that the lateral pharyngeal wall collapse had an increasing tendency associated with higher BMI and AHI [26].

Studies had reported that prevalence of collapse epiglottis on DISE findings is approximately 10–40% and some predictors for more collapse have been documented as epiglottic length with the cutoff value of 16.6 mm on to drug-induced sleep computed tomography [14, 27]. In addition, it has been observed in DISE of patients with poor adherence to PAP that they present significantly greater epiglottic collapse compared to the evaluation of

patients with good adherence to PAP [28]. In our study, we observed that epiglottic collapse was present in 32% of the patients, without being able to associate it with higher PAP initial titration values.

The level PAP initial titration is not related to epiglottis collapse we believe that PAP titration pressure can vary widely in floppy or rigid epiglottis collapse, so to find a pressure level at which collapse occurs is a challenge. To date, knowledge regarding the role of the epiglottis in adult OSA patients is still limited [14, 29].

Our result shows that male gender was significantly associated with not having collapsed epiglottis, in addition patients without epiglottic collapse have a higher mean neck circumference. Our hypothesis is that the primary collapse of the epiglottis does not depend on the fat in the pharyngeal walls, so the cervical perimeter in these patients will not be greater than the other collapses, it depends on the anatomical and histological characteristics of the epiglottis that are still not understood. To date, we have not identified, in previously published literature any association between cervical perimeter and epiglottic collapse.

Eckert and collaborators demonstrate that a patient's requirement for therapeutic PAP shares a strong predictive relationship with their (Passive Critical Upper Airway Closure Pressure) Pcrit; in addition, DISE-guided PAP titration associations have been documented, showing that tongue base collapse and epiglottis collapse were more resistant to PAP pressure [30, 31], our study was unable to establish a cutoff point for the pressure initial titration and the type of collapse. We even found no association between titration median pressure and the types of complex vs. simple collapse.

Different variables for suboptimal auto-adjusting PAP have been identified like male gender and higher values of baseline AHI, 95th percentile pressure, and 95th percentile leak; besides patients with markedly altered respiratory mechanics for PAP titration algorithms suboptimal [17, 32], which we believe could influence the results of our study.

The therapeutic PAP requirement provides important information about the collapsibility of the upper airway, a patient with OSA who has a pcrit < -2 cmH_2O, that is, who has an airway that collapses slightly, could be identified with the level of therapeutic PAP [28]; however, estimate pressures initial titration and types of collapse have not been established, given the complex pathophysiology of OSA with the different phenotypes described to predict therapeutic response.

Even PAP of the same brand use different algorithms to detect flow limitation, different experiences with different self-titration devices, which would be the source of the heterogeneity [18, 33], On our data analysis, patients titrated with bilevel or autoset were not underclassified, being the possible cause of heterogeneity.

However, there are no significant differences regarding the residual OSA severity when positive airway pressure was initiated using home PAP compared to in-laboratory titration, adherence and on daytime sleepiness in adults with OSA is similar with APAP or CPAP; them reduced time to initiation of therapy is potential benefits of APAP titration, all these results based on meta-analysis of 184 studies [32].

In the 2007 the American Academy of Sleep Medicine indicated which patients are not candidates for auto-adjusting positive airway pressure titration or treatment, these are patients with congestive heart failure, chronic obstructive pulmonary disease, hypoventilation syndromes and patients who have central sleep apnea syndromes which is important when considering PAP titration [34].

Finally, we would like to emphasize importance of DISE in predicting response phenotypes to treatment, and the complexity of patients with collapse at the level of the velum, individualization of the patient is necessary.

Limitations

Our investigation has the limitation of being a retrospective and descriptive study. For example, we missed data and had to reduced our study to 37 cases. For data analysis, patients titrated with bilevel or autoset were not underclassified. We wanted to establish the association of titration PAP pressures and complexes collapses and different types of them in DISE, but even though there is a tendency, our small number of patients does not allow us to establish a significant statistical relationship.

Other limitation is that our patients had sleep tests either type 2 or type 3, according to the American Academy of Sleep Medicine (AASM) and even though we think they are good clinical tests, still the gold standar is guarded polysomnography and also for investigation.

Conclusions

In conclusion, our study revealed that complex collapses are characterized by having more concentric velum collapse, we have demonstrated oropharyngeal collapse degree 2 have higher mean AHI, and finally that neck circumference is greater in patients without epiglottic collapse. An association between mean pressure initial titration and complex collapse could not be established. To date, knowledge regarding the role PAP titration and collapse finding on DISE is still limited.

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Declarations

Conflict of interest Authors declare they do not have any conflict of interest.

Ethical approval No ethical approval was required.

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