Drug-Induced Sedation Endoscopy in the Evaluation of OSA Patients with Incomplete Oral Appliance Therapy Response

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

Abstract

Objective. To use drug-induced sedation endoscopy (DISE) to identify locations and patterns of residual collapse in patients with obstructive sleep apnea (OSA) with incomplete response to oral appliance therapy (OAT).

Study Design. Case series with chart review.

Setting. Academic multidisciplinary sleep practice.

Subjects and Methods. Thirty-five consecutively screened adult patients with OSA with continuous positive airway pressure (CPAP) intolerance and incomplete response to OAT (apnea-hypopnea index [AHI] >15 or AHI >5 with persistent subjective symptoms) who underwent DISE with and without the oral appliance. Data collected included demographics, body mass index, polysomnography data, and management decisions after DISE. Each DISE video pair was retrospectively scored using the VOTE classification system by the same blinded reviewer (R.J.S.).

Results. All patients had multilevel airway collapse at baseline. The palate was the most common location of OAT failure. Fifteen (42.9%) had persistent collapse of the velum during DISE with OAT, and 7 (20%) had persistent collapse of the epiglottis. Twenty-three (65.7%) patients were offered targeted surgery based on DISE findings to augment OAT effectiveness. Twenty (57.1%) patients underwent additional medical therapy such as OAT adjustment or cervical positional therapy. Mean AHI was reduced from 37.4 at baseline, to 16.4 with OAT (P < .01), and to 10.7 after post-DISE intervention (P < .78).

Conclusion. In patients with incomplete response to OAT, DISE with and without the appliance can identify residual anatomical locations of collapse, which may direct additional medical and surgical treatment options to augment OAT effectiveness. Further work is needed to determine if DISE affects outcomes.

Keywords

obstructive sleep apnea, continuous positive airway pressure, oral appliance, drug-induced sedation endoscopy

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Obstructive sleep apnea (OSA) is a common disorder characterized by recurrent episodes of upper airway collapse, intermittent oxygen desaturation, and sympathetic activation.¹ Moderate to severe OSA, defined as an apnea-hypopnea index (AHI) of >15 events per hour, is an independent risk factor for hypertension, insulin resistance, and cardiovascular morbidity and mortality.²,³ The application of continuous positive airway pressure (CPAP) therapy can provide significant improvement in symptom and quality-of-life measures as well as a reduction of the cardiovascular risks in patients with moderate to severe OSA,²,³ but its efficacy is significantly limited by patient nonacceptance or inadequate adherence in approximately half of those needing treatment.⁴,⁵

For those patients who are intolerant or unable to achieve benefit with CPAP therapy, a custom-made mandibular repositioning oral appliance can provide an effective alternative (Figure 1).⁶,⁸ Despite good adherence and OSA improvement in 50% to 75% of patients treated with an oral appliance therapy (OAT), approximately half of these patients will have persistent symptoms and/or clinically significant residual sleep apnea on follow-up sleep testing.⁹ Many of these patients will continue with inadequate therapy and subsequent health risks, abandon therapy altogether, or resort to invasive surgical options with less data on effectiveness.

The management of OSA has rapidly evolved over the past decade. Multiple medical and surgical options are available, and treatment plans are increasingly customized

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to each individual’s presentation, anatomy, and pathophysiology. Combination therapy with multiple modalities may be necessary for complete successful management, particularly in patients with severe obstructive sleep apnea.

Drug-induced sedation endoscopy (DISE) is a diagnostic tool used to evaluate the anatomical locations and pattern of obstruction in patients with OSA. Although it was first described in 1991, implementation of DISE into regular clinical practice has only begun to occur in the past several years, and the indications and applications of DISE are still evolving. Prior work has shown that information from DISE can alter preoperative surgical planning, and several studies have demonstrated its utility in predicting oral appliance outcomes.

The current literature does not provide specific guidelines on the timing, indications, or clinical applications of DISE. Furthermore, there is a lack of data on DISE findings in patients with incomplete response to OAT and the implications of these findings for further management, particularly adjunctive medical and surgical options to build on the partial improvement provided by the oral appliance. In these patients with partial benefit but incomplete response, we have implemented a systematic approach involving DISE with and without the oral appliance to better characterize the anatomical locations and patterns of obstruction, to examine the anatomical impact of the oral appliance, and to evaluate for additional potential medical or surgical treatment alternatives to the oral appliance. We hypothesize that DISE improves understanding of the anatomical basis for oral appliance success and failure in these patients and helps to select additional medical or surgical treatment options. This is the first study to describe the specific use of DISE in this clinical setting and to provide insight into how DISE can guide additional management decisions after incomplete response to oral appliance therapy.

Methods
This study was approved by the Institutional Review Board of the University of Pittsburgh. It was designed as a retrospective observational review of adult patients with OSA (18 years of age or older) who were unable to achieve benefit with positive pressure therapy and were subsequently treated with OAT. All patients were treated with the same type of oral appliance (Thornton Adjustable Positioner [TAP-3]; Glidewell Laboratories, Newport Beach, California). Each device was prescribed and fitted by a single sleep dentist with over 20 years of experience in dental sleep medicine (R.R.). The patients studied had persistent or residual sleep apnea (as defined as an AHI >15 on follow-up sleep testing or an AHI >5 with residual symptoms such as snoring or daytime sleepiness) and underwent DISE with and without the oral appliance by the same surgeon (R.J.S.).

In total, 146 consecutive patients were identified from the electronic medical record as having undergone DISE between September 2010 and September 2013. Thirty-five of these patients underwent DISE with and without the oral appliance after they were found to have had incomplete resolution of OSA with OAT, and all were included for analysis to avoid selection bias. Each patient placed the oral appliance in the appropriate anatomic position before induction of anesthesia. Drug-induced sedation endoscopy was then performed as previously described with a gradual propofol infusion and bispectral index monitoring to re-create conditions that mimic the loss of genioglossus muscle activity and the pharyngeal compliance that occurs with sleep. A video recording was produced for each procedure. The endoscopic video recording was then repeated at baseline without the appliance in place.

Each DISE recording was graded by a single reviewer (R.J.S.) using the VOTE classification system in which the upper airway is conceptually divided into structural components composed of the velum, lateral oropharyngeal walls, base of tongue, and epiglottis. Each structural element is then graded on a scale of 0 to 2 with a score of 0 equivalent to no collapse, a score of 1 equivalent to partial collapse, and a score of 2 equivalent to complete collapse. Each structure is also assigned a configuration pattern of collapse (anterior-posterior, lateral, or concentric).

Data collected included patient age, sex, body mass index (BMI), Epworth Sleepiness Score (ESS), diagnostic sleep laboratory data at baseline and with the oral appliance (date, AHI, oxygen saturation nadir, percentage of oxygen saturation less than 90%), documentation of CPAP trial and intolerance, date and operative findings of DISE, and post-DISE interventions. Possible medical interventions included oral appliance adjustment, cervical positional therapy, weight loss, or revisiting CPAP therapy. Possible surgical interventions included septoplasty, inferior submucosal turbinectomy, tonsillectomy, lingual tonsillectomy, advancement palatoplasty, expansion sphincter palatoplasty (done in conjunction with tonsillectomy if not previously performed), or a combination of the above.

All statistical comparisons were completed using the paired Student t tests.

Results
Of the 35 patients included in this study, 9 were women and 26 were men. Mean age was 53.7 ± 9.2 years, with a mean...
BMI of 30.2 ± 4.2 prior to any therapeutic interventions (Table 1).

All included patients reported good subjective adherence and at least partial subjective benefit with OAT, although 22% of patients reported side effects with OAT, including jaw or tooth discomfort, temporomandibular joint pain, or morning occlusal change. All patients also reported at least one persistent symptom of OSA with OAT, including residual snoring or daytime sleepiness. The average time between initial baseline diagnostic polysomnography (PSG) and the follow-up PSG with OAT was 2.3 ± 1.2 years. Patients were found to improve mean AHI significantly from severe OSA at baseline to moderate OSA with OAT (37.4 ± 20.8 to 16.4 ± 16.7; P < .01). Minimum oxygen saturations also improved significantly with OAT (P < .01). A paired t test of ESS could not be completed on patients pre- and post-OAT as post-OAT ESS data were not available on many patients.

All patients had upper airway obstruction during baseline DISE with complete collapse of at least one anatomic structure, while 26 (74.3%) displayed complete collapse of multiple structures (Figure 2A). Eleven (31.4%) patients had complete epiglottic obstruction. With OAT, 15 (42.9%) patients still had complete velum collapse, and 7 (20%) continued to experience complete collapse of multiple structures (Figure 2B). Seven (20%) had persistent complete epiglottic obstruction.

Based on DISE findings, 23 (65.7%) patients were offered anatomically targeted surgical therapy (Figure 3). Twelve (34.3%) of the group were offered a combination of surgical and medical therapy. The remaining 11 (31.4%) were recommended to undergo purely surgical therapy.

A variety of customized, anatomically tailored surgical interventions were employed in the surgical treatment group. Expansion sphincter palatoplasty with tonsillectomy was completed on 10 (28.6%) patients, with 3 continuing to require OAT postoperatively. Seven (20.0%) patients underwent advancement palatoplasty with or without tonsillectomy, with 5 continuing to require OAT postoperatively.

![Figure 2A](https://example.com/figure2a.png)

![Figure 2B](https://example.com/figure2b.png)

**Figure 2.** (A) Observed patterns of complete pharyngeal collapse in patients without oral appliance therapy at baseline. (B) Observed patterns of pharyngeal collapse in patients with oral appliance therapy. Thirteen (37.1%) patients had no complete collapse of any structure.

Four (8.6%) of the surgical patients underwent lingual tonsillectomy or nasal airway surgery (inferior turbinate reduction with or without septoplasty), with 3 also undergoing oral appliance refitting.

Twenty-one (60.0%) patients were treated with medical therapy such as oral appliance adjustment, return to CPAP, or cervical positional therapy, with or without surgery. After review of DISE results and possible treatment options, 9 (20.0%) patients elected for oral appliance refitting or adjustment without additional intervention. Three patients were lost to follow-up after DISE completion before management recommendations could be discussed.

Subjective and objective outcomes were significantly improved from baseline in the 17 (48.6%) patients who completed sleep laboratory testing after therapeutic intervention (mean AHI, 37.4 ± 20.8 to 10.7 ± 9.8, P < .01; ESS, 11.3 ± 4.8 to 7.3 ± 4.5, P < .01; Table 2). Significant AHI improvements were not found compared with post-OAT testing (mean AHI, 16.4-10.7, P < .78).

**Discussion**

This retrospective pilot study highlights the feasibility of a new potential clinical indication and application for DISE: patients with partial but incomplete response to OAT. The results above suggest that incomplete responders to OAT are a complicated subset of patients with OSA with multilevel pharyngeal collapsibility at baseline. The most common

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**Table 1.** Demographic Characteristics of Patients with Obstructive Sleep Apnea.

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>No. or Mean ± SD</th>
<th>Range</th>
</tr>
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<tbody>
<tr>
<td>BMI, kg/m²</td>
<td>30.2 ± 4.2</td>
<td>17-70</td>
</tr>
<tr>
<td>AHI, per hour</td>
<td>37.4 ± 20.8</td>
<td>7-77</td>
</tr>
<tr>
<td>Minimal SaO₂, %</td>
<td>79.7 ± 10.7</td>
<td>51-93</td>
</tr>
<tr>
<td>T &lt; 90, %</td>
<td>19.4 ± 21.5</td>
<td>0-71</td>
</tr>
<tr>
<td>ESS</td>
<td>11.3 ± 4.8</td>
<td>2-19</td>
</tr>
</tbody>
</table>

Abbreviations: AHI, apnea-hypopnea index; BMI, body mass index; ESS, Epworth Sleepiness Scale; SaO₂, oxygen saturation; SD, standard deviation; T < 90, time spent below 90% oxygen saturation.
anatomical reason for inadequate response was failure at the palate; however, the locations and patterns of residual collapse were often multifactorial and variable among patients. A substantial percentage (20%) of patients had persistent hypopharyngeal collapse.

Vroegop et al\(^\text{18}\) previously reported that palatal collapse during DISE with a simulated bite prosthesis was predictive of OAT therapy success, while hypopharyngeal collapse was associated with OAT failure. The results reported here suggest that collapse patterns may be more complicated in patients with incomplete OAT response, as complete palatal collapse with OAT was a point of failure in almost half of the study population.

Other published data support the finding that persistent hypopharyngeal and even multilevel collapse may be a common source of treatment failure with other therapeutic interventions. Farmer et al\(^\text{19}\) used pharyngeal manometry to associate persistent daytime sleepiness after uvulopalatoopharyngoplasty with hypopharyngeal collapse. Riley et al\(^\text{20}\) reported that 9 patients failing palatopharyngoplasty were found on cephalometric radiography to have small posterior airway spaces and inferiorly displaced hyoids, suggesting that surgical failure in focused palatal surgery was also a result of persistent hypopharyngeal collapse. Kezirian\(^\text{21}\) used DISE to examine anatomic outcomes in 33 nonresponders to pharyngeal surgery for OSA and found that many patients had persistent palatal and hypopharyngeal obstruction, often in combination. To our knowledge, this is the first study to use DISE to document the anatomic locations of persistent collapse in patients with only partial responses to OAT.

Drug-induced sedation endoscopy has diagnostic and decision-making value in this population of patients with severe OSA. Continuous positive airway pressure is the standard first-line therapy for severe OSA, but it can present a therapeutic challenge for sleep practitioners when patients are unable to tolerate the physical and psychosocial side effects. Oral appliance therapy can provide a benefit with relatively low risk and morbidity, but efficacy and success rates are more limited and variable in patients with severe OSA. In our clinical experience, many patients with severe OSA with only partial improvement with OAT discontinue using it and either return to previously ineffective CPAP therapy or undergo invasive multilevel surgical procedures. Rather than abandon a partially effective treatment, we decided to systematically implement a DISE evaluation in such patients in

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Table 2. Polysomnogram and Epworth Sleepiness Scale Outcomes with and without OAT and after DISE-Based Recommendations.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>P Value</th>
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<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Post-OAT Treatment</td>
</tr>
<tr>
<td><strong>AHI, per hour</strong></td>
<td>37.4 ± 20.8</td>
<td>16.4 ± 16.7</td>
</tr>
<tr>
<td><strong>Minimal SaO(_2), %</strong></td>
<td>79.7 ± 10.7</td>
<td>81.8 ± 8.5</td>
</tr>
<tr>
<td><strong>T&lt;90, %</strong></td>
<td>19.4 ± 21.5</td>
<td>10.4 ± 12.9</td>
</tr>
<tr>
<td><strong>ESS</strong></td>
<td>11.3 ± 4.8</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: AHI, apnea-hypopnea index; ESS, Epworth Sleepiness Scale; NA, not available; OAT, oral appliance therapy; SaO\(_2\), oxygen saturation; SD, standard deviation; T<90, time spent below 90% oxygen saturation.
an effort to build on the success of the oral appliance or identify alternate therapeutic options.

The treatment decisions that were developed based on DISE findings varied among patients, and in most cases, the DISE findings formed the basis for a patient-centered, customized, combination therapy approach. An example of adjunctive surgical management was targeted palatal surgery to augment the effectiveness of the oral appliance. In patients with primary residual velum collapse but otherwise good anatomical effect of the oral appliance at other sites, a palatal surgery was offered and tailored to the specific palatal anatomy and structure. Examples of adjunctive medical management included oral appliance adjustment or cervical positional therapy. In 1 patient, poor retention of the lower piece of the appliance was noted during DISE, resulting in inadequate mandibular advancement and loss of effect. These findings prompted refitting of the oral appliance by the sleep dentist and subsequent improved subjective and objective outcomes.

This study is limited by its retrospective nature, small population, loss to follow-up, and the heterogeneous anatomy of the included patients. No significant difference was detected in AHI between post-OAT and post-DISE groups in this study, but these results may be confounded by the small and heterogeneous study population as well as the presence of poor surgical candidates within the post-DISE analysis group. The results of specific interventions for specific anatomical subtypes could not be analyzed due to the limited size and heterogeneity of this population. Despite these limitations, our findings support the concepts that the anatomical effect of OAT, vary among patients. It is precisely this complex, heterogeneous population that presents to sleep dentists and otolaryngologists for guidance on the anatomical effect of OAT, varies among patients. It is

Author Contributions

David T. Kent, study concept and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, statistical analysis; Robert Rogers, study concept and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, study supervision; Ryan J. Soose, study concept and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, study supervision.

Disclosures

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References


