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Palatopharyngoplasty Resolves Concentric Collapse in Patients Ineligible for Upper Airway Stimulation

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Objective: To determine if a modified tissue-preserving palatopharyngoplasty could convert retropalatal concentric collapse to anteroposterior or lateral patterns of collapse on drug-induced sleep endoscopy (DISE) in patients who are not candidates for upper airway stimulation due to complete circumferential collapse at the velum.

Methods: A prospective, nonconsecutive, single-blinded cohort study was performed by two sleep surgeons at a tertiary care center from 2015 to 2018. Inclusion criteria included adults > 18 years of age with a diagnosis of obstructive sleep apnea. Twelve patients with complete circumferential collapse underwent a modified palatopharyngoplasty. Postoperatively, a repeat sleep study was performed. A repeat DISE was recommended for those with incomplete surgical response (clinically and/or AHI).

Results: Twelve patients with complete circumferential collapse were eligible for the study. Mean BMI was 30.5. Mean preoperative AHI was 54.0 events per hour. Following a modified palatopharyngoplasty, the mean AHI was reduced to 33.1 events per hour, and 100% (12 of 12) of the patients converted from a pattern of complete circumferential collapse to either no collapse at the level of the velum (3) or an anteroposterior pattern of collapse (9).

Conclusion: We demonstrate that a modified palatopharyngoplasty can successfully convert collapse patterns in patients with complete circumferential collapse. Further studies are required to determine the outcome of these patients following upper airway stimulation implantation.

Key Words: Upper airway stimulation, hypoglossal nerve stimulation, sleep surgery, complete concentric collapse, drug-induced sleep endoscopy, uvulopalatopharyngoplasty, obstructive sleep apnea.

Level of Evidence: 1B

INTRODUCTION

Obstructive sleep apnea (OSA) is increasing in prevalence with approximately 22% of men and 17% of women affected by the disease.1 Although efficacious, rates of continuous positive airway pressure (CPAP) compliance are low, ranging from 17% to 54% across studies, demonstrating that it is often poorly tolerated by patients and thus leaves their disease untreated or undertreated.2,3 The stimulation of the hypoglossal nerve for the management of OSA first demonstrated success in human clinical trials in 1996.4 Upper airway stimulation (UAS) has subsequently found significant, long-lasting clinical success in well-selected patients since its Food and Drug Administration approval in 2014.5,6 Early cohort studies demonstrated high rates of treatment failure in patients noted to have complete circumferential collapse (CCC) (Fig. 1) at the level of the palate on preoperative drug-induced sleep endoscopy (DISE).7 The precise physiologic mechanism of CCC is not well studied, but Steffen et al. found that a higher body mass index (BMI) and a higher apnea hypopnea index (AHI) were predictors of CCC.8 Additionally, Hasselbacher et al. observed that twice as many patients with a BMI > 35 kg/m² had CCC compared to those with a BMI < 35 kg/m². Patients without CCC were also noted to have a lower AHI and a more frequent history of tonsillectomy.9

In a retrospective review examining OSA patients with CPAP failure, Hasselbacher et al. noted that a cohort of patients with a history of a uvulopalatopharyngoplasty (UPPP) and tonsillectomy demonstrated a predominantly anteroposterior pattern of collapse (Fig. 2).10

This prospective, single-blinded cohort study was designed to determine if patients, who are otherwise candidates for UAS but demonstrate CCC on DISE, can be converted to an anteroposterior pattern of collapse following a tissue-preserving modified UPPP.

MATERIALS AND METHODS

Patients

The Institutional review board (IRB) of Stanford University approved the present study (protocol 29182, IRB no. 6208) and

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all procedures were in accordance with the ethical standards of this review board. Informed consent was obtained from all patients included in this study.

A prospective, single-blinded cohort study was performed by two sleep surgeons (S.L, R.C.) in the Division of Sleep Surgery at Stanford University Medical Center, Palo Alto, California, from October 2015 until February 2018. Inclusion criteria were adults > 18 years of age with a diagnosis of OSA and documented CPAP failure who presented to the Stanford Sleep Surgery department for UAS evaluation. In accordance with the STAR Trial inclusion criteria, eligible patients had a BMI < 32, < 25% central apneas, and an AHI > 15 demonstrated on polysomnography. Patients who demonstrated CCC on DISE were offered modified palatopharyngoplasty. No upper limit of AHI was chosen because it was postulated that for those patients with AHI > 65, a modified UPPP could decrease AHI to < 65 events per hour, which is within the range indicated for UAS implantation. Postoperatively, a sleep study was performed, and those with incomplete surgical response underwent a repeat DISE.

Drug-Induced Sleep Endoscopy

DISE was performed in the operating room in a dark, quiet environment. Routine cardiovascular and respiratory monitoring was performed with a Drager Infinity Delta multiparameter system (Drager, Lubeck, Germany). Topical lidocaine jelly was applied to the bilateral nares. Propofol was initiated at a concentration of 1.5 mcg/mL and increased by 0.3 mcg/mL every 2 minutes until a light sleep was induced and fiberoptic nasopharyngoscopy was tolerated. A 3.2 mm flexible scope (Karl Storz GmbH & Co. KG, Tuttingen, Germany) was passed above the inferior turbinate and positioned in the nasopharynx to provide a wide view of the retropalatal and hypopharyngeal regions. At least two cycles of obstructed breathing were observed at each subsite, as recommended by the European position paper on DISE. At the conclusion of the exam, the propofol infusion was stopped, and the patients were awakened and returned to the recovery room. The sleep endoscopies were scored utilizing the VOTE (velum, oropharynx, tongue, epiglottis) classification. Patients included in the study were those noted to have complete circumferential collapse at the level of the velum, excluding them from UAS criteria. The endoscopy scoring results were verified through the review of all DISE videos by a single-blinded sleep surgeon.

Tissue-Preserving Modified Uvulopalatopharyngoplasty

All patients who demonstrated CCC on DISE were subsequently offered tonsillectomy and tissue-preserving modified uvulopalatopharyngoplasty in a fashion previously described by Awad et al. This tissue-preserving technique makes use of three to four 3-0 vicryl sutures appropriated to tension the palatopharyngeus, tensor veli palatini, and levator veli palatini muscles. The uvula was trimmed to a length of 1 centimeter where appropriate. All patients were kept overnight for airway monitoring and discharged home the next day.

Follow-up

At a mean interval from palatopharyngoplasty of 119 days (17 weeks), a repeat polysomnogram that was scored with the updated rules by the American Academy of Sleep Medicine was performed. Those patients who had incomplete surgical results (clinically and/or AHI) returned to the operating room for a repeat DISE, which was performed in the fashion described above. Results were again tabulated according to the VOTE classification and verified by a single-blinded sleep surgeon.

RESULTS

Twelve patients (9 males and 3 females) were eligible for this study. Mean BMI was 30.5 (27.4–32), and the American Society of Anesthesiologists Score was 2.4. Further
Patient 12 (male) underwent tonsillectomy and a modi-

...f 54.0 to 33.1 (14.3 – 28.0). Following modi-

...ed UPPP, mean AHI was reduced from 54.0 to 33.1 (14.3–59) events per hour. Twelve of

<table>
<thead>
<tr>
<th>Patient</th>
<th>Tonsil Size</th>
<th>Tongue Position</th>
<th>Reviewer 1 Preop</th>
<th>Reviewer 2 Preop</th>
<th>Reviewer 1 Postop</th>
<th>Reviewer 2 Postop</th>
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<td>4</td>
<td>OP 1</td>
<td>OP 1</td>
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<td>Tongue 0</td>
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<td>OP 2</td>
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<tr>
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<tr>
<td>Patient 12 (male)</td>
<td>2+</td>
<td>2</td>
<td>OP 2</td>
<td>OP 1</td>
<td>OP 1</td>
<td>OP 1</td>
</tr>
</tbody>
</table>

AP = anteroposterior; CCC = complete concentric collapse; OP = oropharynx; postop = postoperatively; preop = preoperatively.

Baseline demographics are noted in Table I. Mean pre-UPPP AHI was 54.0 events per hour (28.0–89.1). Eighty-four per-

...ped UPPP, mean AHI was reduced from 54.0 to 33.1 (14.3–59) events per hour. Twelve of

Laryngoscope 130: December 2020 Liu et al.: UPPP Can Convert CCC in Patients With OSA
DISCUSSION

A growing number of patients with OSA are seeking alternative therapies to CPAP. For these patients who have failed medical management, surgical intervention has found increasing success in the management of this chronic disease. Growing success in candidate selection and patient outcomes has centered around increased focus on individualized surgical interventions tailored to specific subgroups of patients with particular anatomic phenotypes and sites of obstruction. A tailored treatment algorithm for these patients can be seen in the revised Stanford protocol for sleep surgery. UAS has been an exciting addition to the sleep surgeon’s armamentarium and can be a successful surgical intervention for well-selected patients who are intolerant of CPAP. However, the clinical phenotyping of which patients can best be treated by UAS implantation is a work in progress.

Although a statistically significant reduction in AHI was seen in patients with both AP palatal and tongue-base collapse, Vanderveken and Van de Heyning noted no significant reduction of AHI in patients with CCC who underwent UAS. They theorized that the effects of upper airway muscle activation on upper airway shape was dependent on upper airway cross-sectional area. Thus, anteroposterior movement would not overcome CCC. This beneficial effect of UAS in the A-P dimensions of the upper airway was confirmed by Goding et al. with the use of fluoroscopic imaging during hypoglossal nerve stimulation in 20 subjects. However, Ong et al. and Steffen et al. both noted that 23% and 21% of their patient cohorts, respectively, who were otherwise eligible for upper airway stimulation had CCC on DISE, and Hasselbacher et al. observed that 25% of their patient cohort had CCC on DISE, thus excluding a large cohort of potential candidates from implantation.

Boudewyns et al. first observed changes in patterns of upper airway obstruction following UPPP using intraluminal pressure measurements in 2001. In 2018, in a retrospective cohort study, Hasselbacher et al. noted changes in the patterns of collapse on DISE following UPPP. They performed a series of modified UPPP and tonsillectomies in a fashion proposed by Pirsig et al. on a cohort of patients with all severities of OSA. On postoperative DISE, they noted that 13 of 14 patients had converted from a pattern of CCC to a pattern of A-P collapse, thereby making these patients eligible for UAS. To validate these findings, we performed a prospective, single-blinded cohort study evaluating candidates for UAS who demonstrated CCC on DISE. The same two experienced sleep surgeons performed all sleep endoscopies and modified UPPP/tonsillectomy in a standardized fashion. A third sleep surgeon reviewed all sleep endoscopies in a single-blinded manner, verifying the findings and limiting inter/intraobserver variability. Of 12 patients evaluated, 100% of them had conversion from CCC to alternative patterns of collapse. Also, although the cohort was comprised of primarily UPPP nonresponders, those patients with a preoperative AHI > 65 had a decrease in their AHI to within the range of eligibility for implantation (< 65 events/hour). These findings are of notable significance because, in our small cohort, 100% of patients who were previously ineligible for further surgical management of OSA with UAS due to DISE findings became candidates for UAS following UPPP. This raises the question of whether patients with CCC on DISE and a high likelihood of incomplete response to palatal surgery could have both surgical procedures performed simultaneously. This would improve timing and minimize resource utilization to adequately and appropriately manage their OSA. Further studies are needed to evaluate this cohort of patients post-implantation to determine efficacy and long-term follow-up. Patients must also be counseled because there remain no long-term outcome studies evaluating the efficacy of UAS in patients with previously documented CCC.

Limitations

This study has a nonconsecutive, small sample size of patients who had residual sleep apnea after palatal surgery. Considering that tissue elasticity and patterns of collapse may change with age, we are limited with long-term follow-up regarding patterns of collapse. Also, these patterns of collapse were documented following a modified tissue-preserving UPPP and tonsillectomy technique described by our group, and it is unclear whether other versions of the UPPP will have similar effects.

CONCLUSION

The advent of upper airway stimulation has allowed for significant improvements in the surgical management of obstructive sleep apnea. However, approximately 25% of patients are excluded from implantation due to the demonstration of complete circumferential collapse at the level of the velum on preoperative DISE. Tissue-preserving modified uvulopalatopharyngoplasty can convert these patients from CCC to A-P collapse or no collapse at the level of the velum, thus allowing these patients to become candidates for upper airway simulation. Future work to determine long-term outcomes of patients undergoing UAS implantation after palatopharyngoplasty is in progress.
BIBLIOGRAPHY


