

Feature Article

The Portland Protocol: A Novel, Minimally Invasive Protocol for Treating Obstructive Sleep Apnea

by Geoffrey Skinner, DDS, DABDSM



Dr. Geoffrey Skinner is a Diplomate of the American Board of Dental Sleep Medicine, a board member and Key Opinion Leader for the American Academy of Clear Aligners, and an Invisalign Diamond-level provider. Dr. Skinner maintains a private dental and rejuvenation practice in Portland, Oregon.

He attended dental school at the University of Iowa College of Dentistry. While in dental school, he wrote many top dental apps used by over 100,000 dentists worldwide, including the best-selling dental app in the world, Dental Boards Mastery. He is also a partner in a digital marketing agency for dentists and a founder of the AIR Institute. He is a researcher of laser airway enhancement methods.

Sleep-related breathing disorders from snoring to obstructive sleep apnea (OSA) afflict 9% to 44% of Americans, and occasional snoring is nearly universal.^{1,2,3} Although snoring does not increase a person's risk of dying by as much as OSA, it does increase the risk of stroke by 300%.⁴ Additionally, all events inducing blood oxygen desaturation apply stress to the body in the form of cardiac arrhythmia and cardiac inflammatory events.⁵ We must help our patients improve their airways and ability to remain fully oxygenated if we are to help them live longer and more healthy lives.

The Portland Protocol aims to minimize oxygen desaturation and snoring, with the overall goal of improving total body health, well-being, and longevity in our patients. The Portland Protocol assesses the airway for potential sites of constriction or collapsibility, and then systematically treats those areas. First, we determine the primary causes of snoring or apneic episodes. We assess airway function with sleep study measures. Once assessed, we develop and prescribe a multidisciplinary,

minimally invasive approach to treat the specific areas involved in airway constriction and collapse.

Historically, patient compliance with oral sleep appliances is 93%,⁶ and continuous positive airway pressure (CPAP) machines have a compliance rate of 50%.⁷ However, for being used long enough to prevent cardiac events like heart attacks and strokes, CPAPs have a compliance rate of only about 25%.⁸ This is because most patients use their CPAP at the beginning of the night and take it off in the middle of the night. This is problematic because it means they take their CPAP off before they have most of their REM sleep, and when their apneic episodes are typically more frequent and severe.

Compliance with oral appliances and/or CPAP is directly related to airway improvements,⁶ as CPAPs and oral appliances only assist the airways of patients while they are being used. Compliance greatly improves when sleep apnea treatment is simple and requires minimal effort. Therefore, when requirements for compliance are minimized, as in the Portland Protocol, better airways and better long-term health outcomes should be more easily attained.

The purpose of the Portland Protocol, then, is to provide an introduction and road map for practitioners, who may or may not be currently treating sleep apnea, to introduce an effective multidisciplinary approach to their practice. By including more providers in your treatment planning, you increase the size of your team and the number of clinicians looking for airway complications, leading to increased referrals to your practice. There is too much to know for any single doctor to be proficient at all facets of treatment. Airway management is a team sport!

Exam

An initial complete dental and periodontal examination are performed, along with a comprehensive evaluation of the temporomandibular joint, soft tissues, and nasal complex. A sleep study may be indicated after this initial screening, and questionnaires, if the patient is deemed at risk for OSA.

The Epworth Questionnaire is useful for evaluating how tired or fatigued a patient feels. The Nasal Obstruction Symptom Evaluation (NOSE) questionnaire is often used to check the ability of patients to breathe through their noses. The STOP-Bang (Snoring, Tired, Observed, Pressure, BMI, Age, Neck, Gender) questionnaire is used to screen for the most prominent risk factors of sleep apnea. Each of these questionnaires serves a purpose in determining the relative risk for sleep-disordered breathing.

Dental exam

The dental exam checks for the involvement of teeth in the airway problem. The exam also reveals if modifying tooth position could improve the airway and if the teeth are healthy enough to move them to a better position. Teeth that are lingually tipped apply pressure to the tongue and make it more likely for the tongue to collapse into the throat (i.e., look for scalloping). Having posterior interference means that the jaw can move more anteriorly and superiorly, but is held in a posterior position that is more likely to close off the throat. A worn dentition implies grinding. Airway problems are correlated with tooth grinding, especially in the anterior-posterior direction. This is likely why so many patients with Class II malocclusions, where the maxillary and mandibular anterior teeth do not touch, still demonstrate incisal wear.⁹

Periodontal exam

The periodontal exam identifies whether the patients have buccal recession due to malocclusion, as another clue indicating the possible involvement of teeth in the airway problem. It also serves to determine if the periodontal health of the patient is suitable for the teeth to be moved into a position that is more beneficial to the patency of the airway.

Temporomandibular joint exam

Many patients with sleep apnea report jaw pain, so it is important to know if the patient is having temporomandibular joint dysfunction or myofascial pain. The temporomandibular joint exam reveals any jaw tension or facial tenderness to palpation that could indicate teeth grinding during sleep while struggling for breath.

Soft-tissue exam

Patients with an enlarged tongue have a more constricted airway because the tongue takes up more space.¹⁰ One method of changing the ratio of the tongue to oral cavity volume is myofunctional therapy. Toning the tongue with simple myofunctional exercises can lead to significant airway benefits. Myofunctional therapy is found to decrease the apnea-hypopnea index (AHI) by approximately 50% in adults and 62% in children.¹¹

Tongue ties add resistance to the body of the tongue and make it more likely to fall back into the airway.¹² Deeper soft palates with higher Mallampati scores are less supported and more collapsible.¹³

Nasal exam and nasal breathing

The nasal exam is meant to look for areas of constriction of



Figure 1: nasal valve collapse of the left ala of the nose.

the nasal airway (**Figure 1**). We ask the patient to breathe in quickly and deeply to check for nasal valve collapse that reduces airflow through the nose. Visual examination of the inside of the nose also allows us to search for polyps, inflamed turbinate tissues, and deviation of the septum, which could increase the likelihood of mouth breathing. Mouth breathing leads to a 250% increase in upper airway resistance compared to nasal breathing.¹⁴ Nasal breathing allows 10% to 20% more oxygenation of the blood compared to mouth breathing. This is due to a slowing of the air intake, increasing the oxygen exchange, as well as the intake of nitric oxide, a potent vasodilator that is released by the nasal turbinates.¹⁵ We must do everything possible to help patients breathe through their noses, because otherwise, they are more likely to have a higher risk of apneic events from breathing through their mouths.

Nasal decongestants can be an important tool in helping patients breathe through their noses by decreasing congestion and inflammation of turbinates. Nasal decongestant usage is associated with a decreased AHI, along with improvements in sleep efficiency and non-REM and REM sleep in apneic patients.¹⁶

Many patients with airway problems demonstrate a narrow and raised palate. Raised palates are associated with deviated septums.¹⁷ Depending on the patency of the nose, a referral for a septoplasty may be indicated to improve nasal patency and airflow.

Buteyko breathing exercises and mouth taping may be indicated to help patients learn to breathe through their noses, particularly if they have a previous history of mouth breathing.¹⁸

Nasal dilators can stretch the nasal valve open and prevent its collapse during inspiration. Nasal dilator usage is associated with an 18% average increase in nasal airflow, a significant reduction in snoring, and a 47% reduction in AHI.¹⁹

Airway-centric Invisalign

Clear aligners can increase space in the mouth, particularly for the tongue. When the teeth are tipped lingually, they apply pressure to the tongue, increasing the likelihood of pharyngeal collapse.²⁰ By uprighting and tipping the crowns of teeth to the buccal, we are expanding the dental arch. Expanding the



Figure 2: the wedge effect.

dental arch makes more space for the tongue, and prevents pharyngeal collapse caused by the tongue, improving the airway and the patient's smile at the same time.

To maximize expansion, sometimes it is necessary to intrude the maxillary posterior molars. The reason we intrude the posterior molars is important to note: it is to offset the "wedge effect" (**Figure 2**). As we tip the crowns of the teeth buccally, we simultaneously increase the mandibular plane angle. This, unfortunately, can increase the relative height of the posterior teeth and create an anterior open bite in a process known as the wedge effect, or clockwise rotation of the mandible. By intruding posteriorly, we avoid the wedge effect and bring the anterior aspect of the mandible into a more appropriate position at the finish of the case.

The intrusion of the posterior teeth is simple and predictable with clear aligners.²¹ The intrusion of the maxillary molars can be achieved with occlusal attachments that are not filled with resin, to provide extra pressure to intrude the teeth. Temporary anchorage devices, mini-plates, and elastics can be used if significant amounts of posterior intrusion are indicated.

Posterior intrusion can relieve strong posterior contacts, and allow the jaw to autorotate counterclockwise to a more advanced and superior position. Advancement of the mandible counterclockwise improves patency of the airway because the tongue is moved forward with the mandible and out of the pharynx.²²

Our strategy for orthodontic cases involves a preference for leaving maxillary space to restore instead of making the mouth smaller with interproximal reduction (IPR). Our strategy maximizes the available space for the tongue.

Case

The patient is a 50-year-old male whose chief complaint was "I wake up with headaches a few times a week and have been having jaw pain." The patient had Class I occlusion bilaterally with V-shaped arches and an anterior open bite (**Figure 3**). Based on the exam, we made a plan for orthodontic expansion



Figure 3: patient at baseline with a bilateral Class I occlusion, V-shaped arches, and an anterior open bite.



Figure 4: Invisalign plan to expand and intrude. Aligners with 3 refinements were worn for 13 months with zero auxiliaries.

and intrusion using Invisalign (**Figure 4**). The results of orthodontic treatment are shown in **Figure 5**. **Tables 1-3** list sleep study data at baseline, after Invisalign, and after a third treatment step, NightLase™, described below.

As seen in **Figure 6**, after Invisalign, the patient had greatly improved AHI, snoring, and arousal indices (RDI, REI), as well as lower maximum heart rate during REM sleep (**Table 1**). However, cessation of breathing for 10 seconds or more, 6.5 times per hour, indicated that the patient was still suffering from mild sleep apnea. In addition, the patient was experiencing clinically significant oxygen desaturation events after Invisalign (**Tables 2-3**). To correct these issues, we performed a simple, non-ablative, laser-assisted uvulopalatoplasty procedure called NightLase.

Laser airway management with NightLase

The most well-established and researched laser airway and snoring procedure over the past decade is NightLase. NightLase is a non-ablative laser tightening and elevation of the uvula, soft palate, and surrounding tissues. It does not remove or cut any tissues. Each NightLase case is 3 to 5 sessions of laser treatment, each session approximately 20 minutes in length. The sessions are 3 to 4 weeks apart to allow for maximum neocollagenesis.²³ Because NightLase is non-ablative, anesthetic is not needed. The NightLase procedure uses both wavelengths of the Fotona LightWalker laser: Nd:YAG and Er:YAG. The effect of these lasers is to tighten collagen,²⁴ thereby making the soft palate more open and less collapsible. The deeper tissues are pulled together via mechanical tension between the layers. Both of these mechanisms result in a 66% average decrease in AHI,²⁵ which is on par with what would be expected with an oral appliance, but without the need for compliance or the potential risk of complications like jaw pain or unwanted changes to the bite.

NightLase decreases snoring,²⁶ increases airway volume,²⁷ and decreases AHI.²⁵ The tightening of collagen in the soft palate moves it more anteriorly, and allows for better airflow even through the nasopharynx, resulting in improved nasal breathing.²³ The tightening of collagen can also lift the soft palate and change the Mallampati score. Many patients have an immediate, visible rise in the soft palate (**Figure 7**). The average improvement of snoring after 1 session has been shown to



Figure 5: patient after Invisalign. More space is available for the tongue following Invisalign treatment.

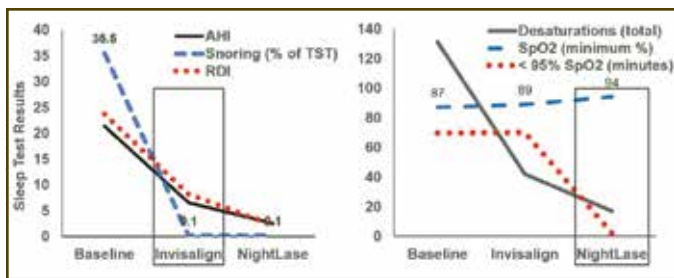


Figure 6: sleep test results at baseline, after Invisalign, and after NightLase. Left: Snoring and apneic episodes decreased after Invisalign. Right: Respiratory measures and oxygen saturation were clinically impaired even after Invisalign, but were in a healthy range after NightLase. AHI: apnea-hypopnea index (number per hour); RDI: respiratory disturbance index (number per hour); TST: total sleep time; SpO₂: oxygen saturation.



Figure 7: before (left) and after (right) NightLase non-ablative uvulopalatoplasty and lingual pyroptosis and photobiomodulation using Er:YAG and Nd:YAG lasers.

Table 1: sleep test data at baseline, after Invisalign, and after NightLase.

	Baseline	Invisalign	NightLase
Lights Off (Date, Time)	2/29/2020 22:43	9/15/2020 22:33	9/1/2021 21:13
Lights On (Date, Time)	3/1/2020 6:31	9/16/2020 5:52	9/2/2021 6:02
Total Recording Time (minutes)	860.7	915	931
Time in Bed (minutes)	467.7	437.8	528.4
Time in Bed (TIB; hours, minutes)	7, 48	7, 18	8, 48
TIB (% of total recording time)	54.3	47.8	47.8
Total Sleep Time (minutes)	437.4	407.4	517.4
TST (% of TIB)	93.5	93.1	97.9
Sleep Efficiency (% of TIB)	93.5	93.1	97.9
Apnea Hypopnea Index (AHI, number per hour)	21.4	6.5	2.5
Respiratory Event Index (number per hour)	22.3	7.7	2.7
SpO ₂ ¹ < 89% (cumulative minutes)	3	0	0
SpO ₂ < 89% (longest span, minutes)	1	0	0
Snoring (minutes)	155.2	0.3	0.1
Maximum heart rate, REM (bpm)	100	93	86

¹SpO₂: oxygen saturation

be about 50%, and after the third session, 85%.²⁸ The effects of the NightLase procedure last 9 to 24 months.²⁹ Patients are encouraged to return on an annual basis or sooner if needed for a single session to maintain their airway.

Figure 6 shows the clinical improvements after Invisalign and 2 NightLase sessions, as only 2 sessions were needed to get average SpO₂ over 96% and minimum SpO₂ to 94% (**Tables 2-3**). The patient will be returning for maintenance sessions, and we are likely to see further improvement at follow-up. Invisalign decreased snoring, AHI, and arousal measures, but had minimal effect on respiratory indices (**Figure 6**). Subsequent treatment with NightLase decreased AHI even more, and improved respiratory function. The minutes

the patient had <95% oxygen saturation were greatly reduced by NightLase. This was associated with decreased maximum heart rate during REM sleep as well as improved sleep efficiency (**Table 1**). The patient reported better nasal breathing, and no pain or adverse effects of the treatment. However, the patient came in for an exam after the first NightLase session complaining of “non-painful, non-fluid-filled areas on the back of his tongue.” Examination suggested that what he was seeing was his circumvallate papillae that were now visible after the inflammation of his tongue was reduced with the NightLase procedure.

Although Invisalign brought him from moderate apnea to mild apnea, Invisalign alone was not adequate to bring respiratory

Table 2: sleep study measures for all sleep stages and total time in bed at baseline, after Invisalign, and after NightLase.

	REM			Non-REM		
	Baseline	Invisalign	NightLase	Baseline	Invisalign	NightLase
Average SpO ₂ ¹ (%)	95.5	95.1	96.4	95.5	95.1	96.2
Desaturations (number)	131	42	17	133	43	18
Minimum SpO ₂ (%)	87	89	94	87	89	94
<95% (minutes)	69.5	70.0	2.1	71.8	77.4	10.4
<90% (minutes)	1.1	0.1	0	1.3	0.1	0
<85% (minutes)	0	0	0	0	0	0
No Signal/Artifact (minutes)	0.0	0.2	0.1	0	0.5	0.2

¹SpO₂: oxygen saturation**Table 3: sleep study measures during REM and non-REM sleep.**

	REM			Non-REM		
	Baseline	Invisalign	NightLase	Baseline	Invisalign	NightLase
Average SpO ₂ ¹ (%)	95.7	95.1	96.1	95.5	95.0	96.0
Desaturations (number)	44	23	9	87	19	8
Minimum SpO ₂ (%)	89	89	94	87	90	94
<95% (minutes)	18.2	22.7	3.7	51.3	47.3	4.3
<90% (minutes)	0.1	0.1	0	1.0	0	0
<85% (minutes)	0	0	0	0	0	0
No Signal/Artifact (minutes)	0	0	0	0.0	0.2	0.1

¹SpO₂: oxygen saturation

measures into a healthy range. Further treatment of the soft tissues using NightLase is an essential component of the Portland Protocol that we have seen eliminate the need for CPAP or appliances in many patients.

Expiratory positive airway pressure (EPAP)

EPAPs work by applying positive pressure upon exhalation, keeping the airway open until the next inhalation.³¹ EPAPs are useful for patients who have collapsible nasal valves as well as a collapsible pharynx and are unwilling or unable to go through NightLase. One EPAP device FDA has cleared to treat obstructive sleep apnea is called the Bongo Rx.

Mandibular advancement

Patients that have residual obstructive desaturation events after orthodontics, NightLase, or nasal breathing aids may require a mandibular advancement appliance to prevent the jaw from falling back during REM-associated atonia. Advancing the mandible or increasing the vertical dimension may be helpful to fully treat the patient.

A study by Anitua et al. found that 81% of patients get a maximal decrease in AHI from protrusions ≤ 3 mm and that 39% of patients experienced a ≥ 50% reduction in AHI with advancement of zero mm.³² This study suggests that oral appliance therapy is less about advancing the mandible and more about preventing the jaw from falling back and collapsing the airway.

Expanding the arch before oral appliance therapy helps create space and may decrease the amount of advancement needed to resolve the airway constriction. Decreasing the amount of protrusion means that the patient is less likely to experience appliance-related complications like changes in the bite and/or temporomandibular joint dysfunction or pain.³³

In summary, adding simple techniques like non-ablative laser uvulopalatoplasty, which is highly tolerable by patients and has predictable results, to the Portland Protocol can eliminate the need for CPAP or oral appliances in some cases of sleep apnea, thereby removing issues of patient compliance.

We have found that opening space for the tongue does much of the work in eliminating snoring and apneic episodes, but

may not fully resolve sleep apnea in some patients. As there are compliance issues with CPAP and oral appliances, and they only help with airway issues while they are being used, NightLase should be considered a first-line treatment. NightLase improves breathing 24 hours a day and requires no compliance.

A multidisciplinary approach that considers the use of orthodontic alignment, expansion, NightLase, and as a last resort, compliance-dependent CPAP and/or oral appliances, is the best way to offer simple, customized sleep apnea treatment. ■

References:

- Senaratna CV, Perret JL, Lodge CJ, et al. Prevalence of obstructive sleep apnea in the general population: A systematic review. *Sleep Med Rev*. 2017 Aug;34:70-81. doi: 10.1016/j.smrv.2016.07.002.
- Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med*. 1993 Apr 29;328(17):1230-1235. doi: 10.1056/NEJM199304293281704.
- American Academy of Sleep Medicine. *International Classification of Sleep Disorders*. 3rd ed. Darien, IL: American Academy of Sleep Medicine; 2014.
- Spriggs DA, French JM, Murdy JM, Curless RH, Bates D, James OF. Snoring increases the risk of stroke and adversely affects prognosis. *Q J Med*. 1992 Jul;83(303):555-562.
- Korantzopoulos P, Letsas KP, Tse G, Fragakis N, Goudis CA, Liu T. Inflammation and atrial fibrillation: A comprehensive review. *J Arrhythm*. 2018 Jun 4;34(4):394-401. doi: 10.1002/joa3.12077.
- Vanderveken OM, Deltjens M, Wouters K, De Backer WA, Van de Heyning WA, Braem MJ. Objective measurement of compliance during oral appliance therapy for sleep-disordered breathing. *Thorax*. 2013 Jan;68(1):91-96. doi:10.1136/thoraxjnl-2012-201900.
- Wolkove N, Baltzan M, Kamel H, Dabrusin R, Palayew M. Long-term compliance with continuous positive airway pressure in patients with obstructive sleep apnea. *Can Respir J*. 2008 Oct;15(7):365-369. doi: 10.1155/2008/534372.
- Agency for Healthcare Research and Quality, U.S. Department of Health and Human Services. *Draft Technology Assessment: Continuous Positive Airway Pressure Treatment for Obstructive Sleep Apnea*. April 2021. Available at: <https://www.ahrq.gov/sites/default/files/wysiwyg/research/findings/ta/drafts-for-review/sleep-apnea-draftreport.pdf>. Accessed September 25, 2021.
- Wetselaar P, Manfredini D, Ahlberg J, et al. Associations between tooth wear and dental sleep disorders: A narrative overview. *J Oral Rehabil*. 2019 Aug;46(8):765-775. doi: 10.1111/joor.12807.
- Kim AM, Keenan BT, Jackson N, et al. Tongue fat and its relationship to obstructive sleep apnea. *Sleep*. 2014 Oct 1;37(10):1639-1648. doi: 10.5665/sleep.4072.
- Camacho M, Certal V, Abdullatif J, et al. Myofunctional Therapy to Treat Obstructive Sleep Apnea: A Systematic Review and Meta-analysis. *Sleep*. 2015 May 1;38(5):669-675. doi: 10.5665/sleep.4652.
- Guilleminault C, Huseni S, Lo L. A frequent phenotype for paediatric sleep apnoea: short lingual frenulum. *ERJ Open Res*. 2016 Jul;2(3):00043-2016. doi: 10.1183/23120541.00043-2016.
- Liistro G, Rombaux PH, Belge C, Dury M, Aubert G, Rodenstein DO. High Mallampati score and nasal obstruction are associated risk factors for obstructive sleep apnoea. *Eur Respir J*. 2003 Feb;21(2):248-252. doi: 10.1183/09031936.03.00292403.
- Fitzpatrick MF, McLean H, Urton AM, Tan A, O'Donnell D, Driver HS. Effect of nasal or oral breathing route on upper airway resistance during sleep. *Eur Respir J*. 2003 Nov;22(5):827-832. doi: 10.1183/09031936.03.00047903.
- McKeown P. *The Oxygen Advantage: Simple, Scientifically Proven Breathing Techniques to Help You Become Healthier, Slimmer, Faster, and Fitter*. New York, NY: William Morrow; 2016.
- McLean HA, Urton AM, Driver HS, et al. Effect of treating severe nasal obstruction on the severity of obstructive sleep apnoea. *Eur Respir J*. 2005 Mar;25(3):521-527. doi: 10.1183/09031936.05.00045004.
- Sapmaz H, Kavakli A, Sapmaz HI, Ögetürk M. Impact of Hard Palate Angulation Caused by Septal Deviation on Maxillary Sinus Volume. *Turk Arch Otorhinolaryngol*. 2018 Jun;56(2):75-80. doi: 10.5152/tao.2018.2987.
- Sano M, Sano S, Oka N, Yoshino K, Kato T. Increased oxygen load in the prefrontal cortex from mouth breathing: a vector-based near-infrared spectroscopy study. *Neuroreport*. 2013 Dec 4;24(17):935-940. doi: 10.1097/WNR.000000000000008.
- Höijer U, Ejnell H, Hedner J, Petruson, Eng LB. The effects of nasal dilation on snoring and obstructive sleep apnea. *Arch Otolaryngol Head Neck Surg*. 1992 Mar;118(3):281-4. doi: 10.1001/archotol.1992.01880030069015.
- Sunny S, Joseph DP, Mathew N, Rajan RS, Kurian E. Three-Dimensional Control on Lingually Rolled in Molars using a 3D Lingual Arch. *J Clin Diagn Res*. 2017 Aug;11(8):ZR01-ZR03. doi: 10.7860/JCDR/2017/28742.10503.
- Glassick A, Gluck AJ, Kottelman W, Messersmith M. Aligner Corner: Evaluating the Efficacy of Lower Incisor Intrusion with Clear Aligners. *J Clin Ortho*. 2017 Apr;51(4):233-239. Available at: <https://www.jco-online.com/archive/2017/04/233-aligner-corner-evaluating-the-efficacy-of-lower-incisor-intrusion-with-clear-aligners/>. Accessed September 25, 2021.
- Mehra P, Downie M, Pita MC, Wolford LM. Pharyngeal airway space changes after counterclockwise rotation of the maxillomandibular complex. *Am J Orthod Dentofacial Orthop*. 2001 Aug;120(2):154-159. doi: 10.1067/mod.2001.114647.
- Shiffman HS, Lukac M. NightLase: minimally invasive laser-assisted uvulopalatoplasty. *J Laser Health Acad*. 2018;2018(1):39-44.
- Unver T, Aytugur E, Ozturan O, Kiran T, Ademci E, Usumez A. Histological effects of Er:YAG laser irradiation with snoring handpiece in the rat soft palate. *Photomed Laser Surg*. 2016 Aug;34(8):321-325.
- Shiffman HS, Khorsandi J, Cauwels NM. Minimally invasive combined Nd:YAG and Er:YAG laser-assisted uvulopalatoplasty for treatment of obstructive sleep apnea. *Photobiomodul Photomed Laser Surg*. 2021 Aug;39(8):550-557. doi: 10.1089/photob.2020.4947.
- Miracki K, Vizintin Z. Nonsurgical minimally invasive Er:YAG laser snoring treatment. *J Laser Health Acad*. 2013;2013(1):36-41.
- Lee CYS, Lee CCY. Evaluation of a non-ablative Er:YAG laser procedure to increase the oropharyngeal airway volume: a pilot study. *Dent Oral Craniofac Res*. 2015 July;1(3):56-59. doi: 10.15761/DOCR.1000113.
- Monteiro L, Macedo A, Corte-Real L, Salazar F, Pacheco JJ. Treatment of snoring disorder with a non-ablative Er:YAG laser dual-mode protocol. An interventional study. *J Clin Exp Dent*. 2020 Jun 1;12(6):e561-e567. doi: 10.4317/jced.56953.
- Shiffman HS. Breakthrough non-surgical laser sleep applications in dentistry and medicine. *J Dent Res Pract*. 2020;4:1-3. doi: 10.15761/JDRP.1000117.
- Sippus J. Case Report: Nightlase Procedure – Laser Snoring and Sleep Apnea Reduction Treatment. *J Laser Health Acad*. 2015. Available at: https://www.laserandhealthacademy.com/media/objave/academy/priponke/sippus_laha_2015_onlinefirst.pdf. Accessed September 25, 2021.
- Rosenthal L, Massie CA, Dolan DC, Loomas B, Kram J, Hart RW. A multicenter, prospective study of a novel nasal EPAP device in the treatment of obstructive sleep apnea: efficacy and 30-day adherence. *J Clin Sleep Med*. 2009;5(6):532-537. doi: 10.5664/jcsm.27653.
- Anitua E, Durán-Cantolla J, Almeida GZ, Alkhraisat MH. Minimizing the mandibular advancement in an oral appliance for the treatment of obstructive sleep apnea. *Sleep Med*. 2017 Jun;34:226-231. doi: 10.1016/j.sleep.2016.12.019.
- Sheats RD, Schell TG, Blanton AO, et al. Management of side effects of oral appliance therapy for sleep-disordered breathing. *J Dent Sleep Med*. 2017;4(4):111-125. doi: 10.15331/jdsm.6746.



Visit our “Case of the Month” section on the AACA website.
Post your comments and read what your peers have
to say about each case – www.aacaligners.com