Dental Sleep Medicine Case Studies

16

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Abbreviations

AADSM	American Academy of Dental Sleep Medicine
AHI	Apnea-hypopnea index
BMI	Body mass index
CBCT	Cone beam computerized tomography
CPAP	Continuous positive airway pressure
DSA	Dental sleep appliance
EDS	Excessive daytime sleepiness
ESS	Epworth sleepiness scale
GERD	Gastroesophageal reflux disorder
HST	Home sleep test
MAD	Mandibular advancement device
MMI	Maximum medical improvement
MRA	Mandibular repositioning appliance
O_2	Oxygen
OAT	Oral appliance therapy
ODI	Oxygen desaturation index
OSA	Obstructive sleep apnea
OTC	Over the counter
PAP	Positive airway pressure
PLM	Periodic limb movement
PSG	Polysomnography
RDI	Respiratory disturbance index
REM	Rapid eye movement

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G. G. Demerjian et al. (eds.), *Dental Sleep Medicine*,
https://doi.org/10.1007/978-3-031-10646-0_16

RERA	Respiratory effort-related arousals
SpO_2	Oxygen saturation
TMJ	Temporomandibular joints
TST	Total sleep time

16.1 Introduction

The major problem of dentists doing dental sleep medicine is knowing when they achieve success in their therapy. Dentists have thought that in order to reach a successful outcome with dental sleep appliance therapy, they had to match the results of continuous positive airway pressure (CPAP), which is apnea-hypopnea index (AHI) less than 5. Research has shown that treatment with dental sleep appliances (DSA), also known as oral appliance (OA), mandibular advancement device (MAD), or mandibular repositioning appliance (MRA), may be as effective, long term, as CPAP therapy [1–4]. In addition, there are many more factors that need to be taken into consideration other than AHI. This chapter will discuss the American Academy of Dental Sleep Medicines (AADSM) definition of success for DSA therapy. Several cases will be discussed showing possible treatment modalities to improve outcome [5].

The first definition of successful DSAT was approved by the board of directors of the AADSM in 2013. A task force was formed by the AADSM to research, review, and update this definition, reaching a final approval by the board on March 2019 and is as follows:

The purpose of a DSA is to treat obstructive sleep apnea (OSA), primary snoring, and associated symptoms. Effective DSAT is best achieved when it is provided by Qualified Dentists. A properly fitted DSA worn nightly will decrease the frequency and/or duration of apneas, hypopneas, respiratory effort related arousals (RERAs) and/or snoring events. DSAs have been demonstrated to improve nocturnal oxygenation as well as the adverse health and social consequences of OSA and snoring. DSAs are indicated for patients with mild to moderate OSA and primary snoring. DSAs are an accepted therapy for patients with severe OSA who do not respond to or are unable or unwilling to tolerate positive airway pressure (PAP) therapies. Although DSAs are typically used as a stand-alone therapy, with some patients they may be prescribed as an adjunct to PAP therapy and/or other treatment modalities for the management of OSA [5].

A DSA is custom fabricated using digital or physical impressions and models of an individual patient's oral structures. A custom-fabricated DSA may include prefabricated components; however, it is not primarily prefabricated. It is fabricated with biocompatible materials which are trimmed, bent, relined, and modified engaging both the maxillary and mandibular arches. The DSA has mandibular advancement mechanisms in increments of 1 mm or less with a protrusive range of at least 5 mm. The mechanisms may or may not include fixed mechanical hinges or metallic materials. Furthermore, the advancement mechanism must be reversible and

verifiable. The DSA should easily be placed and removed by the patient or caregiver. It should maintain a stable retentive relationship on the dentition, dental restorations, or edentulous ridges, without dislodging at the prescribed setting during use when sleeping [6].

This definition is very thorough in scope, but still didn't answer the question that many dentists have, which is what specifically is AHI and other factors that need to be considered. In the past, we looked at DSA therapy that didn't achieve a reduction of less than 5 AHI for mild OSA, less than 10 AHI for moderate, and a decrease of at least 50% of the AHI in a severe apneic as a failure. The AADSM now considers an AHI of less than 10 for mild and moderate OSA to be a success and 50% decrease of AHI in the severe apneas to be considered a success. Some of the other factors that should be considered, along with AHI, might be hypoxia not controlled and desaturations of under 90%, apnea unchanged or worsened while on DSA therapy, arousal index, sleep architecture, sleep efficiency, daytime sleepiness, quality of life, hypertension, adherence of treatment, bite change, patient still tired in the morning, erectile dysfunction, and mood changes [1, 2].

It is highly recognized that CPAP therapy is the best treatment for OSA patients as long as they comply with the use of the mask or nasal pillows for the duration of their sleep time. The standard of care for DSA therapy is for the treatment of snoring, mild and moderate sleep apnea, and even being able to treat severe cases if the patient is intolerant to the use of the CPAP machine. The major problem with CPAP therapy is, even though patients comply with recommended and recognized treatment time (4 h per night for five nights per week), this may leave them untreated for a large portion of their sleep [7, 8]. This problem may reduce the efficiency of the CPAP treatment to a less-than-desired level [9]. CPAP therapy has better efficacy when treating severe OSA in most cases as it will reduce AHI and respiratory disturbance index (RDI) better than most DSAs can accomplish. When considering lack of CPAP use during total sleep time to more tolerable DSA, the efficiency of both treatments has similar results [9–11].

In an article titled *Clinical Practice Guideline for the Treatment of Obstructive Sleep Apnea and Snoring with Oral Appliance Therapy: An Update for 2015* published in the Journal of Clinical Sleep Medicine in 2015, the task force concluded these findings regarding DSA therapy [12].

1. DSA therapy is effective for the treatment of primary snoring in adult patients without obstructive sleep apnea [1, 13, 14].
2. DSA therapy can reduce the AHI in adult patients with OSA [1–4, 11, 15–20].
3. DSA therapy moderately improves minimum oxygen saturation in adult patients with OSA [1, 2, 11, 16, 20–22].
4. DSA therapy can reduce the arousal index in adult patients with OSA [2, 4, 11, 20, 22–26].
5. DSA therapy can reduce the oxygen desaturation index (ODI) in adult patients with OSA [21, 22, 27, 28].
6. Custom titratable DSAs are equivalent to CPAP in reducing subjective daytime sleepiness in adult patients with OSA [2, 4, 13, 14, 16, 17, 21–23, 27–29].

7. DSA therapy is nearly equivalent to CPAP for improving the quality-of-life measures in adult patients with OSA [13, 21, 22, 27, 29].
8. DSA therapy is nearly equivalent to CPAP in reducing blood pressure in adult patients with OSA [21, 27, 30].
9. The adherence with DSAs is better overall than with CPAP in adult patients with OSA [13, 14, 21, 27, 30–32].
10. Side effects that are serious enough to cause patients to discontinue the use of their DSAs are less common than side effects causing adult patients with OSA to discontinue the use of CPAP [1, 4, 13, 14, 21, 27, 31–35].

Several cases are presented below, and many will show that treating OSA with DSAs is a multifaceted problem where dentists need to be well versed and trained in reading and understanding sleep studies (see Chap. 7) and different supplemental treatments (see Chap. 12) to accomplish favorable outcomes. Dentists need to understand that this treatment is not a one-size-fits-all-type approach and should be knowledgeable in the use of the many different DSAs. If success isn't achieved at first, one must look at other potential solutions such as CPAP, myofunctional therapy, surgery, and co-treatments. See previous chapters.

16.2 Case Studies

16.2.1 Case Study #1: Severe Apnea Treated with DSA, Positional Therapy, and Nasal Aids

16.2.1.1 Background

K.M. was referred for possible OSA and snoring problems. His primary care physician was concerned with his symptoms and wanted a home sleep test (HST) performed to determine whether indeed an OSA problem was present. His occupation has him working different shifts weekly (mostly nights), and this also has an effect on his sleep and sleep hygiene. K.M. is a well-developed male with a height of 71 in. and weight of 230 lb resulting in a body mass index (BMI) of 32.08. He takes no medications, except Flonase for seasonal allergies. He has chief complaints of fatigue, forgetfulness, snoring, daytime sleepiness, dry mouth, and a disturbed sleep pattern. His Epworth sleepiness scale (ESS) was registered as 12 on the scale. K.M. had no previous sleep study performed, so a two-night study with a Z machine portable monitoring HST was done. This unit has EEG leads, so a sleep physician can interpret typical sleep parameters and look at the brain wave activity. The two-night study revealed that K.M. had severe sleep OSA (AHI 77.5/h), significant O_2 desaturations (RDI 78.6/h), and loud snoring 54% of the total sleep time (TST).

16.2.1.2 Clinical Exam

K.M. had expressed a desire to have a DSA instead of CPAP and stated that he would not wear the PAP mask. A comprehensive examination was performed which included palpations of the muscles of mastication, neck, and shoulder along with a

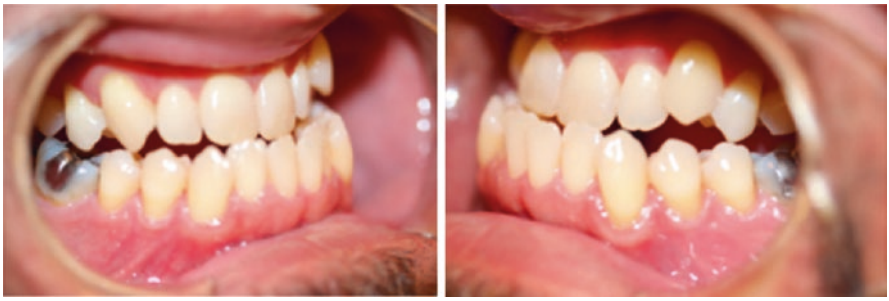

Fig. 16.1 Pretreatment images of the patient K.M. documenting the occlusion with Class III bite relationship

temporomandibular joint and an intraoral examination. The muscle examination revealed no tenderness of any of the examined muscles, the nasal airway presented with moderately inflamed turbinates, and the oropharyngeal airway showed a narrowing at the base of the tongue. His dental evaluation revealed no present caries, no mobile teeth, and missing teeth #1, 16, 17, and 32. The range of motion was normal (interincisal opening 58 mm, 11 mm right lateral, 12 mm left lateral, and 8 mm protrusive). The exam also revealed a Class III dental relationship (Fig. 16.1), underdeveloped maxilla, no periodontal disease, good dental hygiene, and no temporomandibular joint (TMJ) noise. Intraoral examination revealed medium-sized tongue with scalloping present, tonsils were absent, Mallampati classification was 4, uvula was normal, and the pharyngeal walls were level 2 bilaterally.

16.2.1.3 Radiographic Exam

A cone beam computerized tomography (CBCT) X-ray was performed to evaluate the TMJ, nasal airway, and oropharyngeal airway. CBCT revealed a normal bilateral condylar position of the TMJ, moderately inflamed nasal turbinates, deviated nasal septum to the right, and narrow oropharyngeal airway at the base of the tongue (Fig. 16.2).

16.2.1.4 Treatment Recommendations

K.M. was shown three different DSAs and chose to be treated with a KAVA dorsal fin type (Fig. 16.3). Upper and lower impressions were taken, and a phonetic bite was taken for the dental relationship that the appliance was to be made to.

16.2.1.5 Treatment

Two weeks after the records appointment, the DSA was inserted, an AM Aligner was constructed to reposition the jaw back to the original bite every morning after removal of the DSA, and the patient was given instructions on use and care. Instructions were provided on how to titrate the DSA. As most of the AHI episodes occurred while in a supine position, position therapy was recommended.

K.M. returned for a 2-night titration study, and the results showed a very significant decrease in AHI (8.9/h) and oxygen desaturation index (ODI) (9.6/h),

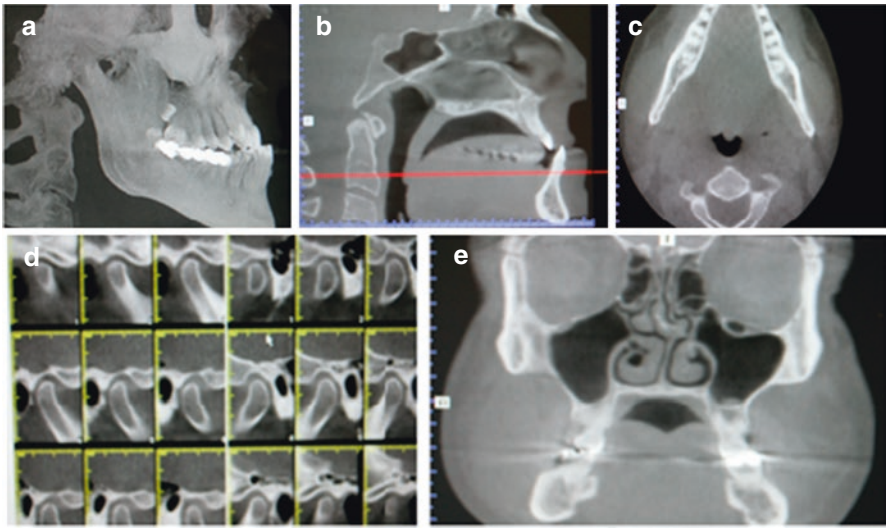

Fig. 16.2 (**a**) Upper left figure indicates significant underbite; (**b**) upper middle figure (red line) indicates cross-section through the narrowest oropharyngeal airway, at the soft palate, and the base of the tongue; (**c**) upper left figure indicates smallest oropharyngeal airway; (**d**) lower left figure indicates a condylar position slightly posterior within the temporal fossa; (**e**) lower right figure indicates significant nasal issues with inflamed turbinates and left side deviation of the septum

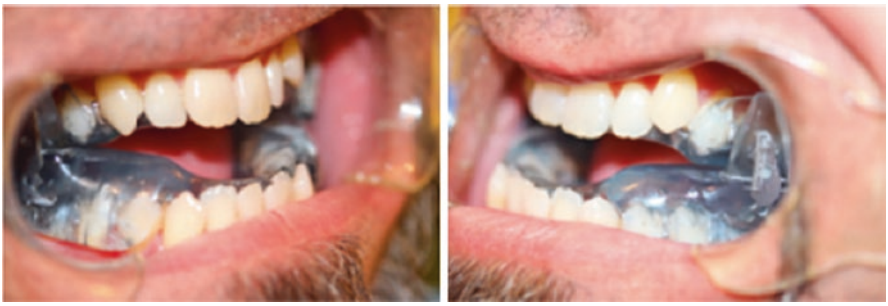

Fig. 16.3 Treatment images with the dental sleep appliance (KAVA dorsal fin) in the patient's mouth with slight anterior advancement and increased vertical

and snoring decreased to 34.8% of TST. No further titration was recommended due to his significant underbite. In order to address the nasal patency issue, the patient was fitted with nose cones and given Xlear nasal spray to see if this could further reduce the AHI. The patient called stating that his wife said the snoring is much better since starting the new protocol. K.M. feels that the remaining issues have to do with sleep schedule changes, due to the shift work. K.M. is happy with the results that we have achieved and will be monitored on recall visits.

16.2.1.6 Treatment Summary

The treatment for the patient was considered a success by the standards the AADSM has set as the AHI was reduced by a lot more than the required 50% reduction. The nasal cones and position change from mainly the supine position have also worked well for the patient.

16.2.1.7 What We Learned

Dentists who treat DSM need to be well versed in the many different factors that can either result in success or failure. If the positional therapy had not been addressed, the DSA treatment alone would still have been a success by the standards set by the AADSM, but not to the level that was achieved. The nasal cones also contributed to the success for the patient. The CBCT showed that the right and left condyles were in a good centric relation position even with the significant Class III bite, and too much advancement could possibly have been detrimental to the health of the temporomandibular joints.

16.2.2 Case Study #2: Severe Apnea Treated with a Dental Sleep Appliance

16.2.2.1 Background

D.B. presented for complaints of excessive daytime sleepiness, fatigue, and feeling unrefreshed in the morning. The patient was considering the use of a DSA to help with his diagnosis of severe OSA and snoring. The results of the polysomnography (PSG) indicated severe OSA in the supine position, AHI 33.1/h, and RDI 35.9/h. Periodic limb movements (PLM) were less than 5/min. The lowest oxygen saturation (O_2) 92.2% with the mean saturation being 94.7%. Patient tried CPAP therapy for a few nights, but complained of non-restful sleep due to the noise made by the machine and felt no improvement of symptoms.

D.B. is a well-developed male weighing 200 lb and height 6 ft 1 in. Both the Berlin questionnaire and ESS were administered at the initial examination. He tested positive for the Berlin test and the ESS score was 15. The BMI was computed to be 26. D.B. presents with a medical history of hypertension, high cholesterol, chronic sinusitis, takes antacids for the gastroesophageal reflux disorder (GERD), morning dry mouth, and wisdom teeth extractions. He has a family history of hypertension and OSA. D.B. denies the use of alcohol, tobacco, sedatives, and caffeine within 2–3 h of bedtime. His chief complaints are frequent heavy snoring, stopping breathing during sleep, and also gasping on waking.

16.2.2.2 Clinical Exam

During the clinical examination, the following results were noted: the tongue appeared enlarged and retracts into the airway on opening, the tongue above the occlusal plane, and Mallampati Class 3. Swallow was normal, tonsils grade 2, elongated and edematous uvula, and the soft palate appeared to obstruct the airway. The

rhinometry testing indicated open-nasal passages and normal turbinates. TMJ exam revealed muscles of mastication to be normal; no joint noise was found when examined with a Doppler stethoscope. Missing teeth were #1, 16, 17, and 32, the range of motion was normal range with an interincisal opening of 49 mm, right lateral movement of 10 mm, left lateral movement of 11 mm, and a 9 mm protrusive movement. The maxilla was moderately vaulted maxilla and narrow mandibular arch.

16.2.2.3 Radiological Exam

Panoramic X-ray revealed no apparent pathology; tomograms of the TMJ show bilateral condyles slightly posterior and superior in the glenoid fossa, with no apparent symptoms present. Cervical X-ray shows a one-dimensional narrowing of the pharyngeal airway (Fig. 16.4).

16.2.2.4 Treatment Recommendations

When consulting with D.B. about treatment options, the patient had no desire to try the CPAP again or have surgery and wanted to try the DSA like his wife, as she had experienced great results. Several DSAs were shown and risk/benefits were discussed with the patient. He decided to try the SomnoMed MAS appliance as this had many of the options which he desired. Impressions and bite relationship were taken with a 5 mm George gauge device for the SomnoMed MAS (Fig. 16.5).

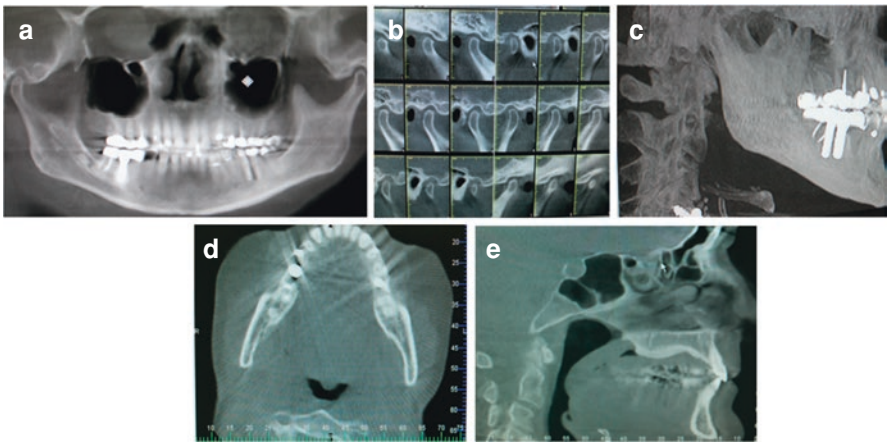

Fig. 16.4 (**a**) The upper left figure is a panoramic X-ray indicating multiple restorations with slight gonial angle. (**b**) The upper center figure is tomography indicating the mandibular condyles slightly posteriorized in temporal fossa. (**c**) The upper right figure is a lateral cephalometric view showing a loss of curvature of the neck. (**d**) The lower left figure is the cross section of the oropharyngeal airway indicating narrowing. (**e**) The lower right figure indicates narrowing of the oropharyngeal airway at the soft palate and base of the tongue

Fig. 16.5 SomnoMed MAS. (Image courtesy of SomnoMed laboratory)

16.2.2.5 Treatment

D.B. returned after 3 weeks for insertion of the DSA. Instructions were given, and the patient was advised to return in 3 weeks for a follow-up visit. He was seen again after 1 month, to monitor improvements, and again he reported that he really liked the DSA. A HST was recommended with the Watch Pat to titrate the DSA further if needed. The HST results looked very good, so the patient was referred for an overnight PSG, and the report is as follows: The AHI reduced significantly from 33.1/h to 5.0/h rapid eye movement (REM) sleep AHI of 6.2/h mean oxygen saturation became 94.4% with the lowest being 91.5%. D.B. was very happy with his treatment results and continues wearing his DSA. This case meets the current requirement for success, and the patient has remained pleased for several years as we monitor the patient and his DSA yearly.

16.2.2.6 Treatment Summary

The patient was treated successfully with just a DSA by moving the lower jaw forward and also supporting the musculature of the oropharyngeal airway. The oxygen levels remained about the same during the before and after sleep studies and discussed possible contributing factors, such as the size and position of the tongue, loss of tone of the soft palate, and elongated uvula. The patient is still compliant with the DSA after 6 years of treatment, and the appliance is still performing well for him.

16.2.2.7 What We Learned

Severe OSA can be treated successfully in many cases with a DSA if the correct one is chosen for the patient. Tongue size and tongue position can play an important factor in the success or failure in each case. A DSA with minimal material on the lingual should be chosen in many cases. The nasal component cannot be overlooked in any OSA treatment as many people have inflamed turbinates which can obstruct the nasal passages. In the preliminary screening, the nasal airway passages should always be considered and addressed.

16.2.3 Case Study #3: Noncompliant CPAP Patient with Moderate Sleep Apnea Treated Successfully with an EMA DSA

16.2.3.1 Background

M.L. presented for a consultation seeking treatment for her moderate OSA and snoring with a DSA. The results of the PSG indicated an AHI 20.8/hr. with a mean oxygen saturation of 94.5%.

M.L. presents as a well-developed Caucasian female of 55 years of age. Her current height is 6 ft 1 in and weight is 222 lb. Her ESS score was 6 and the Berlin sleep evaluation graded at positive for sleep apnea, with a BMI of 29. Her chief complaints were feeling unrefreshed upon awakening, significant daytime drowsiness, morning headaches, frequent heavy snoring which bothers her spouse, difficulty falling asleep, and sometimes gasping when waking up. She had a trial with CPAP, which she was unable to tolerate due to an unconscious need to remove the mask during sleep, interruption of sleep caused by the presence of the device, and feeling claustrophobic.

M.L. reported having sinus surgery, which resulted in no improvement of symptoms. She reports being allergic to iodine and adhesive in tape. Currently medication being taken are Merida (diet pills), Levoxyl, Cytomel, Zyrtec D, and Boneva. She reports chronic sinus problems with headaches, insomnia, morning dry mouth, nighttime sweating, osteoarthritis, recent weight gain, thyroid problems, swollen joints, previous tonsillectomy, previous orthodontic treatment, and wisdom teeth extraction.

16.2.3.2 Clinical Exam

A clinical exam was performed and revealed the following: enlarged tongue with a Mallampati Class 4, high tongue level (Fig. 16.8), tonsils and adenoids absent, swallow and gag reflex normal, normal-sized uvula, firm soft palate, nasal passages and normal turbinates, mandible and maxilla normal, mild periodontal disease present, and right and left posterior temporalis muscles slightly tender. A TMD evaluation performed with a Doppler microphone was normal, maximum interincisal opening of 49 mm, and right and left lateral excursions of 11 mm each and 8 mm protrusion.

Pharyngometry testing taken at several jaw positions revealed that the airway increased significantly when the mandible was protruded and vertical increased. The best position was found and labeled so it could be repeated. Rhinometry testing indicated a slight decrease of air volume present, so the patient was instructed to use an over-the-counter (OTC) nasal spray and may possibly need a steroid nasal spray.

16.2.3.3 Radiological Exam

A radiological survey was performed with a panoramic X-ray which reveals slight antegonial notching and multiple dental restorations present. Lateral cervical spine X-ray revealed a kyphotic cervical relationship and narrowing of the oropharyngeal airway. Tomography revealed bilateral decrease in the joint space between the mandibular condyle and temporal fossa (Fig. 16.6).

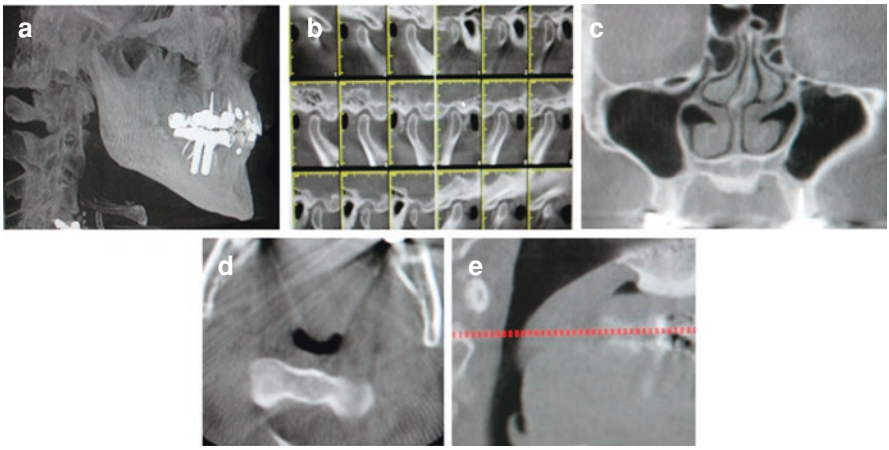

Fig. 16.6 (**a**) The upper left figure indicates slight antegonial notching and kyphotic cervical area. (**b**) The upper center tomography indicates bilateral condyles slightly posterior and superior positioned within the temporal fossa. (**c**) The upper right figure indicates inflamed nasal turbinates and deviated septum. (**d**) The lower left figure is a cross section of the oropharynx shows narrowing. (**e**) The lower right figure is a sagittal view, the red line indicating narrowing behind the soft palate and base of the tongue

Fig. 16.7 EMA. (Image courtesy of Apex Dental Sleep Laboratory)

16.2.3.4 Treatment Recommendation

Several different FDA-approved DSAs were demonstrated discussing the risk/benefits of each. M.L. chose the looks and design of the elastomeric mandibular advancement (EMA) DSA (Fig. 16.7). Upper and lower impressions and a construction bite with a 5 mm George gauge instrument were taken which duplicated the best position for construction of the appliance.

16.2.3.5 Treatment

The EMA was inserted and instructions on usage and care were provided. At the 2-week follow-up visit, the patient reported better sleep, not snoring (confirmed by husband), but still waking early. Titration instructions were given, and extra straps were provided for advancement as necessary.

M.L. returned for a 2-month follow-up visit reporting that symptoms stayed improved, so a Braebon portable monitor was administered, showing good results. During her 6-month follow-up visit, the patient still reported no changes, so M.L. was referred to a sleep center for a PSG study with the EMA DSA. She was extremely satisfied with the results of the dental sleep appliance as is the patient. The PSG results are as follows:

16.2.3.6 Summary of Treatment

Initial PSG readings:

AHI reading of 20.8/h with REM AHI 8.9/h
Average oxygen saturation of 94.5% with a low of 82%
Ninety-five respiratory events during the study

PSG with the EMA appliance in place:

AHI reading of 0.5/h with REM AHI 1.6/h
Average oxygen saturation of 96.4% with a low of 92.0%
Three respiratory events during the study

Great results were achieved with DSA therapy where OSA is non-existent during REM and NREM sleep. The patient also reported weight loss of 25 lb during the DSA therapy and has noticed much more energy.

16.2.3.7 What We Learned

A patient with a larger tongue and scalloping of the lateral borders usually has a narrower lower arch and can benefit from a DSA that is very thin on the lingual of the lower part of the DSA. The EMA offers this and was very successful in this patient with very little advancement. The patient still exhibits some O_2 issues and could benefit from some nasal oxygen or the use of nose cones, mute dilators, or nasal buttons embedded into the DSA. We discussed this with the patient, but she is happy with the treatment and has no desire to change anything. The weight loss has definitely helped also (Fig. 16.8).

16.2.4 Case Study #4: Severe Noncompliant CPAP Patient with TMD Treated Successfully with a DSA

16.2.4.1 Background

J.R. presented for a consultation concerning the possibility of using a DSA to help with her OSA and snoring. She was diagnosed with severe OSA and had a trial with the CPAP.

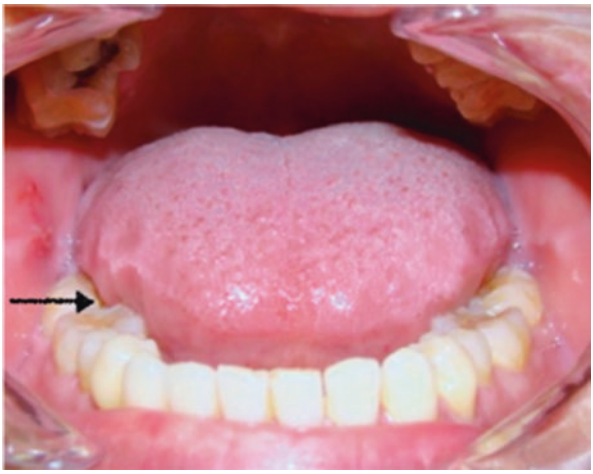

Fig. 16.8 Large and scalloped tongue resting above the occlusal plane of the teeth. Arrow on the side of the tongue is pointing to the scalloping where the tongue is taking the shape of the teeth. (Image reprinted with permission [36])

J.R. presents with chief complaints of frequent heavy snoring, having been told that she stops breathing when sleeping, gasping when waking, feeling unrefreshed upon awakening, morning headaches, and jaw clicking. J.R. is a well-developed middle-aged lady with a medical history of awaking with a dry mouth, irregular heartbeat, osteoarthritis, recent excessive weight gain, and swollen, stiff, and painful joints. Current medications are OTC anti-inflammatory drugs and Evista, 60 mg daily.

The patient reports a family history of heart disease, hypertension, diabetes, and OSA. J.R. reports daily use of alcohol within 2–3 h of bedtime. She presents with a weight of 163 lb, height of 5 ft 2 in., ESS 10, Berlin sleep evaluation positive for OSA, and BMI 32. The original PSG results revealed that J.R. suffered from severe OSA with an AHI 38.5/h and mean oxygen saturation of 95.8%. A split night study was performed where a CPAP was administered during the second half of the night. She reported not tolerating the CPAP due to mask leaks, discomfort from the straps and headgear, disturbed sleep caused by the CPAP, noise from the CPAP disturbing her sleep, CPAP restricted her movements during sleep, and there was an unconscious need to remove the CPAP during the sleep.

16.2.4.2 Clinical Exam

Examination revealed enlarged and scalloped tongue; the tongue level lies above the occlusal plane, Class 1 occlusion (Fig. 16.9), Mallampati Class 3, tonsils grade 1, uvula is elongated, patent nasal passages, maxilla is moderately vaulted, and she has healthy periodontium. Palpations elicited slight tenderness bilateral temporalis muscles, left preauricular region, left masseter, sternocleidomastoid and trapezius muscle. Bilaterally the right and left TMJs exhibited and early opening click and a late closing click. Maximum interincisal opening was 46 mm, bilateral lateral movement 10 mm, and protrusive movement 7 mm.

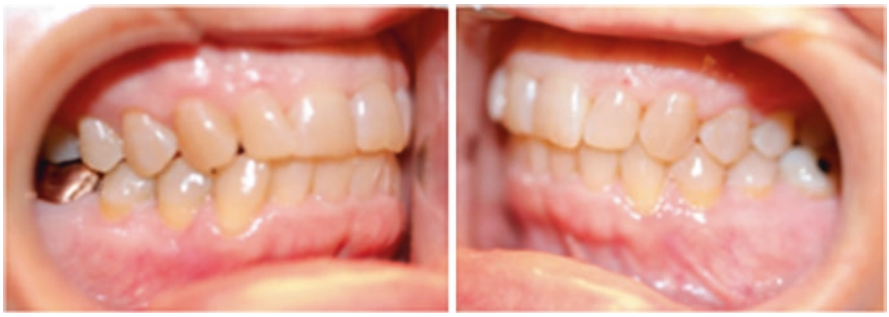

Fig. 16.9 Pretreatment images of the patient (R.J.) documenting Class I occlusion

16.2.4.3 Radiological Exam

A radiological survey included: Panorex X-ray revealed severe antegonial notching, multiple restorations present, and deviation of the nasal septum to the right side. Lateral cervical spine X-ray revealed a significant narrowing of the oropharyngeal airway and compression of the cervical vertebrae C4–C7. Tomograms showed bilateral TMJ condyles positioned posterior and superior in the glenoid fossa (Fig. 16.10). Tenderness of the masseter and temporalis muscles along with the antegonial notching would indicate a potential bruxism problem and could be due to TMD issues or narrowing of the oropharyngeal airway.

16.2.4.4 Treatment Recommendations

Several different FDA-approved DSAs were demonstrated discussing the risk/benefits of each. J.R. chose the EMA DSA. Upper and lower impressions were taken along with a bite relationship that placed her at an end-on-end relationship and sent to the lab for fabrication.

16.2.4.5 Treatment

Upon insertion of the EMA (Fig. 16.11), J.R. was seen at a 3-week follow-up visit, where an adjustment was made to the DSA. Then she was seen twice at 3-month intervals for evaluations and adjustments of the DSA. Upon questioning, J.R. reported that her TMD problems were much better and she had less joint noises than when we started the treatment.

She had a follow-up PSG with the EMA to see the efficacy of the appliance. An adjustment was made midway during the sleep study. J.R. was very happy with the DSA and reported feeling refreshed upon awakening and overall has much more energy, so the patient was advised to return in 1 year for a yearly checkup.

16.2.4.6 Summary of Results

Initial PSG readings

AHI of 38.5/h
Average oxygen saturation of 95.8%

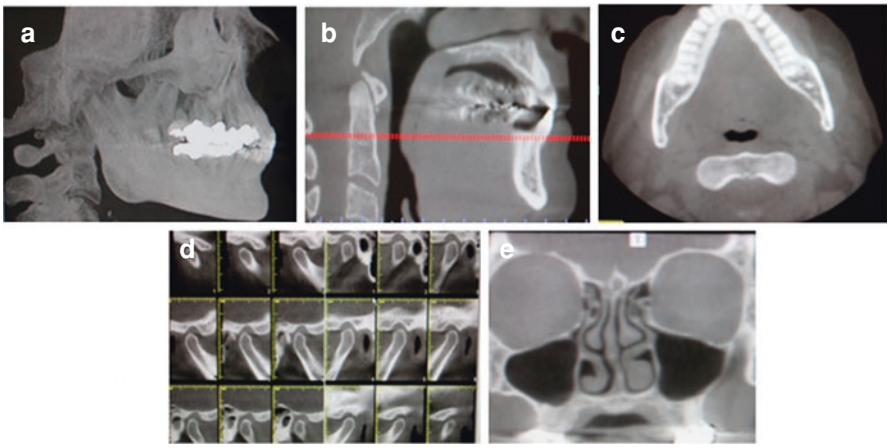

Fig. 16.10 (**a**) The upper left figure is a lateral view indicating gonial angle notching. (**b**) The upper center figure indicates soft tissue narrowing of the oropharyngeal airway. (**c**) The upper right figure is a cross section at oropharyngeal airway indicating narrowing. (**d**) The lower left figure is tomography showing the mandibular condyles slightly posteriorized. (**e**) The lower right figure indicates slight septum deviation and normal nasal passages

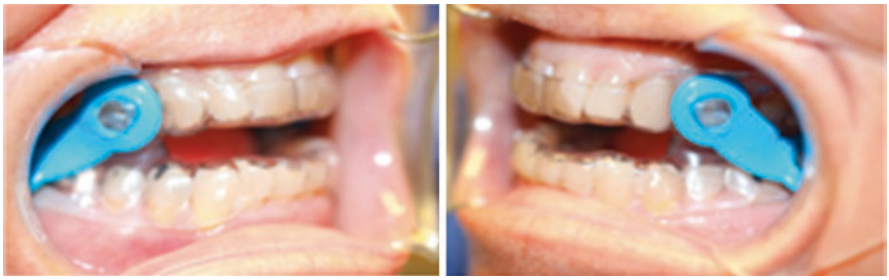

Fig. 16.11 Treatment photos of the jaw position and EMA appliance in the patient's mouth

Readings with the EMA in place

AHI of 4.2/h with REM AHI 6.7/h
Average oxygen concentration of 94.8% with a low of 89.0%
Total of 28 respiratory events took place

The AHI had a significant decrease with the use of the EMA, which helps with overall total sleep. The oxygen remains about the same, but the total number of respiratory events decreased. The patient was advised that supplemental oxygen could be used to help with the oxygen saturation, but she is extremely happy with treatment to this point and declined this.

16.2.4.7 What We Learned

Many patients who present for OSA treatment also have an underlying or active TMD problem. This should be taken into consideration when treating OSA patients to make sure that during treatment, the TMD problem is either also treated or that we don't make their TMD problem worse. This can be accomplished by advancing the mandible too much forward or increasing the vertical dimension of the DSA. DSA selection is very important. The doctor should be familiar with many different types of DSAs to choose the most appropriate for the patient and not have a one-size-fits-all mentality.

16.2.4.8 What to Do

What to do when a patient has jaw pain due to bruxism when wearing the DSA? Measure the range of motion and assess if the problem is muscular or joint related. As the mandible is advanced during the titration phase of using the DSA, the condyles may not be symmetrical, and the occlusion of the appliance may be off balance. Start by checking and balancing the occlusion of the DSA. If you suspect a muscle spasm or myalgia, the patient should be placed on OTC anti-inflammatory medications or Cyclobenzaprine 10 mg; use a warm compress on the face over the masseters and perform jaw stretching exercises. If the patient has severe pain at the joints on palpation and you suspect inflammation, one can prescribe a Medrol Dosepak. If pain persists, the dentist should do a full TMJ evaluation or refer out to an orofacial/craniofacial pain specialist.

16.2.5 Case Study #5: A Patient that Developed a Significant Bite Change During DSA Treatment But Needed Further Advancement to Treat the Apnea Along with Positional Therapy

16.2.5.1 Background

Patient M.B. was referred by her dentist concerned about her bite relationship changing from a Class I position to Class III (end-on-end occlusion) (Fig. 16.12). M.B. has been using a Narval DSA for the past 2 years and has been extremely compliant with the use of morning positioners and bite tabs to keep her occlusion from changing. The dentist wanted to see what we could do to try to get her jaw back into the Class 1 relationship with her teeth occluding in the posterior area. Her sleep study wasn't presented at this time as her major concern was the occlusion, and this was her complaint.

16.2.5.2 Clinical Exam

An examination was performed including palpations of the neck, shoulder, and facial areas to determine if there were any muscle conditions present. Intraoral examination revealed missing teeth #1, 16, 17, and 32; medium tongue size; tonsils absent; Mallampati Class 3; and uvula normal; and pharyngeal walls were level 2 bilaterally. When trying to retrude the mandible, it was impossible to move it

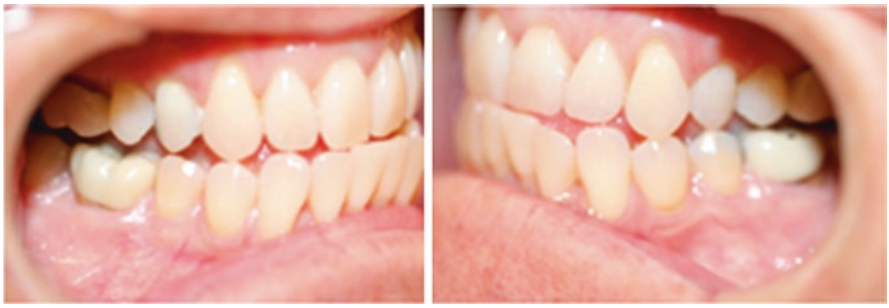

Fig. 16.12 Pretreatment photos of occlusion for patient M.B. Notice the patient has class III occlusion due to previous DSA therapy

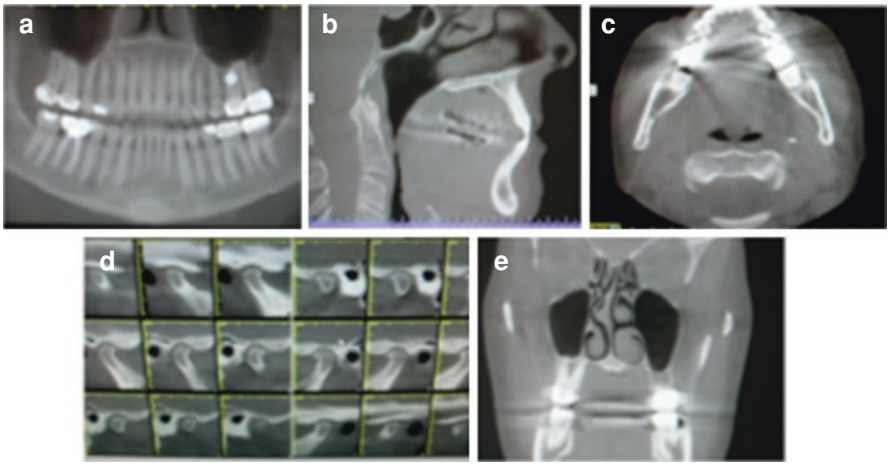

Fig. 16.13 (**a**) The upper left figure is a panoramic view. (**b**) The upper center figure is a lateral view of the soft tissue indicating a very narrow oropharyngeal airway. (**c**) The upper right figure is a cross section indicating narrow oropharyngeal airway. (**d**) the lower left figure is a tomography of the mandibular condyles indicating slight posterior positioning. (**e**) The lower right figure is a nasal view indicating a deviated septum to the right and inflamed turbinates. Three-dimensional imaging is very necessary as you can see in (**b**) and (**c**), where the lateral view shows a complete obstruction, but the transverse section shows open airways lateral to the uvula

posterior and felt like the lateral pterygoid muscles had contracted to help hold the jaw forward. A TENS unit was used to deprogram and relax the muscles with no success in changing the relationship.

16.2.5.3 Radiological Exam

A CBCT X-ray showed normal bilateral condylar position. The oropharyngeal area was slightly narrow at the base of the tongue, the nasal areas showed a mild increase in size, and sinuses were clear (Fig. 16.13).

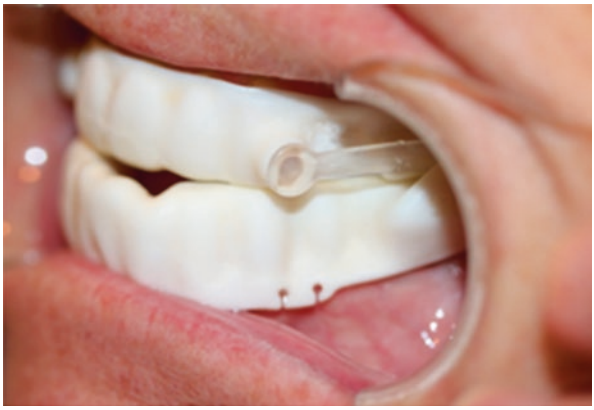

Fig. 16.14 Treatment photo of the jaw position with the Narval appliance in the patient's mouth

16.2.5.4 Treatment

A mandibular appliance (stabilization splint) was fitted for the patient to use during the daytime to try to help change her dental relationship, but after several months of use, no change was evident. Her daily headaches and neck pain had disappeared. During this time, the rods of the DSA were lengthened in order to posteriorize the lower jaw to her normal occlusion. As treatment progressed, M.B. started complaining of daytime sleepiness, fatigue, and snoring. Since her old sleep study was not available, a new PSG was requested, revealing an overall AHI 31.8/h and during REM sleep AHI 67.1/h Furthermore, during supine position, AHI was 67.1/h, indicating that increase in AHI was positional dependent.

At M.B.'s next visit, position therapy was discussed. She sewed a pocket into her nightshirt and placed some tennis balls into the pocket. The Narval DSA was titrated by changing the rod to achieve satisfactory results (Fig. 16.14). Two different titration studies were done over a 2-month period and at the last study, demonstrated an AHI 5.8/h with an ODI of 4.8/h. Treatment was also supplemented with "MUTE" nasal dilator after her last visit to try to help with the ODI.

16.2.5.5 Summary of Results

Pre-treatment PSG

AHI 31.8/h
Supine AHI 67.1/h
Oxygen Desaturation 65.2/h

Post-treatment PSG

AHI 5.8/h
Oxygen desaturation 4.8/h

16.2.5.6 What We Learned

Treatment of M.B. shows that doctors need to be well educated in all the realms of treating sleep issues. She presented with probable contractions of the lateral

pterygoids holding her jaw forward, OSA mainly dependent on supine sleeping position, possible TMJ problems, and nasal issues that all had to be looked at to achieve the desired results. Long-term use of a DSA which protrudes the jaw can cause a change of the occlusion, even when the patient is diligent with morning exercises. This patient's condyles are slightly posterior even with the bite change. The dentist must be careful when treating OSA patients because many have a potential TMD problem even though they may be asymptomatic at the time of treatment.

16.2.6 Case Study #6: Moderate Apnea with Severe Oxygen Desaturations Treated with DSA and Positional Therapy

16.2.6.1 Background

D.M. presented for a consultation considering the possibility of using a DSA to help with her OSA and snoring. She was referred by the sleep physician who performed the original PSG and CPAP titration study. She is 5 ft 6 in., weighs 180 lb, and current medications are Zolof, 25 mg daily; Zetia, 10 mg daily; iron supplement daily; and multivitamin daily.

D.M.'s chief complaints for seeking treatment are frequent snoring, daytime drowsiness, stops breathing when sleeping, and feeling unrefreshed upon awakening. ESS score is 21, Berlin sleep evaluation is positive for potential OSA, and the BMI is 29. Previous PSG revealed moderate OSA with significant snoring. D.M. had a total of 133 episodes during sleep, AHI 22/h, supine position AHI 37/h, and lowest SpO_2 75% during apneic events. D.M. stated that she was CPAP intolerant due to mask leaks, discomfort by the straps and headgear, and disturbed sleep; the noise bothers her bed partner and the removal of the CPAP during the night.

16.2.6.2 Clinical Exam

Clinical exam revealed a medium-sized tongue, a Mallampati Class 2, absent tonsils and adenoids, normal uvula and soft palate, and a narrow mandible. Pharyngometry testing indicated a significant increase in airway by bringing the jaw forward to an end-on-end relationship, and rhinometry revealed slight occlusion in the right nostril. TMD screening revealed normal muscles on palpation, interincisal opening of 45 mm, and right and left lateral movements of 9 mm and protrusive movement 7 mm. The TMJ exam revealed bilateral mild crepitus. Oral examination revealed missing teeth #1, 4, 13, 16, 17, 20, 29, and 32; mild attrition was noted (Fig. 16.15); no mobility of teeth; and moderate gingival inflammation.

Fig. 16.15 Pre-treatment models showing the occlusion. Notice the deep bite and attrition

16.2.6.3 Radiological Exam

Panoramic X-ray revealed slight antegonial notching and multiple restorations. Lateral cervical spine X-ray revealed a narrowing of the airway and increased mandibular angle. Tomographic X-rays revealed bilateral condyles positioned posterior and superior in the glenoid fossa and bilateral mild arthritis. The nasal X-ray showed moderate inflammatory changes and lateral cephalometric X-ray showed a narrowing posterior to the base of the tongue (Fig. 16.16).

16.2.6.4 Treatment Recommendations

Several different FDA-approved DSAs were demonstrated discussing the risk/benefits of each. D.M. chose the SomnoMed MAS appliance. Upper and lower impressions were taken, and a bite relationship (Fig. 16.17) was sent to the lab for appliance fabrication.

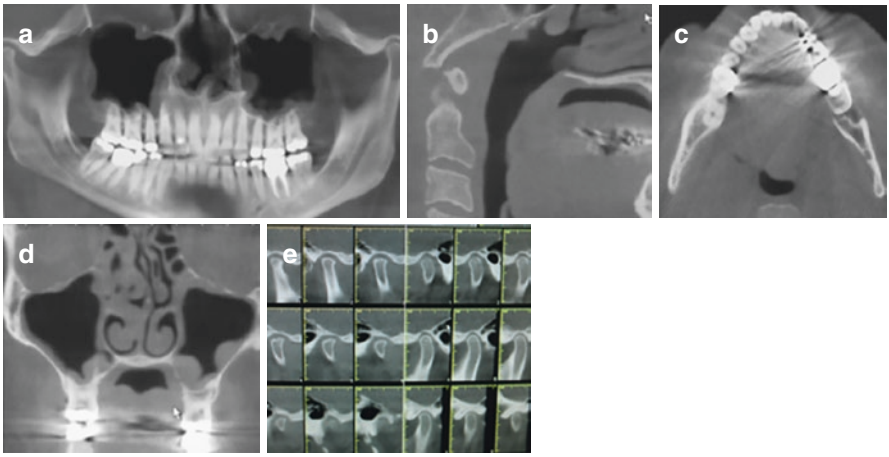

Fig. 16.16 (**a**) The upper left figure is a panoramic view indicating inflammation of the nasal passages. (**b**) The upper center figure is a lateral view of the soft tissue of the oropharyngeal airway. (**c**) The upper right figure is a cross section of the oropharyngeal airway indicating a narrowing. (**d**) The lower left figure indicates inflammation of the maxillary sinus and deviation of the nasal septum. (**e**) The lower right figure is tomography of the mandibular condyles indicating arthritic changes of the left condylar head (flattening on the superior aspect and beaking) and bilateral displacement of the condyles posterior and superior

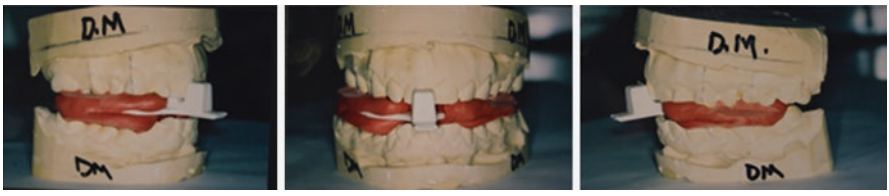

Fig. 16.17 Photos show the bite registration on the models showing the starting bite position for the SomnoMed MAS dental sleep appliance

16.2.6.5 Treatment

Upon insertion of the DSA, instructions for use were provided. Sleeping in the supine position and position therapy were discussed at length for the patient to attempt. D.M. returned for a 2-week evaluation and expressed that she felt much better and more rested. Another pharyngometry test was performed to titrate the DSA to the best reading. Symptoms reported were less snoring, waking refreshed, and feeling more wide-awake. Pulse oximeter testing was done, revealing an average SpO_2 of 94% with one episode of SpO_2 at 88% lasting 24 s.

D.M. was advised to titrate the DSA even more to help improve the results. She went back to the sleep physician for a new overnight PSG (test results are below). The test revealed that we have been able to reduce AHI by 50% to a mild level and a higher SpO_2 level. Treatment has helped with the supine OSA, but snoring is still present sometimes. D.M. was happy with the results, but the treatment is still ongoing trying to improve the results. The patient is seen for follow-up visits to monitor occlusion, dental health, and progress. On the last visit, D.M. reported no TMD issues, bite changes, or movement of her teeth. She doesn't miss the CPAP at all and is enjoying the freedom of using the appliance.

16.2.6.6 Summary of the PSG Tests Before and During the Oral Dilator

Initial PSG testing:

AHI 22/h with REM AHI 37/h
Lowest oxygen saturation of 75%
One hundred thirty-three respiratory events present with 113 occurring in the supine position

Testing when the SomnoMed MAS appliance is place:

AHI of 12.2/h
Lowest single-oxygen desaturation of 87% (one time)
Thirty-seven respiratory events present with 30 occurring in the supine position

16.2.6.7 Treatment Summary

D.M. reports that she feels like the appliance is working well for her. It was recommended that she try Breathe Right nasal strips to see if this would help further lower the AHI index by helping to open the nasal airway and also recommended trying to change her sleep position to sleep more on her side and went over some of the ways that this could be accomplished. The patient was advised to CPAP if she wanted further improvement. Further titration is recommended to see if more improvement can be obtained. D.M. was very happy with treatment and refused both the nasal strips and the recommendation to use her CPAP. This case is considered a success due to the 50% decrease in AHI, but we should always be looking for ways to try to get better results. The ultimate result depends on patient cooperation and compliance to recommendations.

16.2.6.8 What We Learned

Even though the case was considered a success by the standards and by the patient's happiness with treatment, the author should have tried to be more forceful with the pursuit with an ENT for nasal issues or with the supplemental oxygen. She also refused the use of any other nasal aids. The dentist has to recognize that it is up to the patient to follow up on the recommendations and that it is our responsibility to offer recommendations.

16.2.7 Case Study #7: Moderate Sleep Apnea with Excessive Daytime Sleepiness Treated with DSA and Nasal Components

16.2.7.1 Background

The patient was referred by his primary care doctor for evaluation for a DSA to manage his moderate/severe OSA. The patient had attempted CPAP but was intolerant to the therapy. The patient had an initial diagnostic HST, attempted CPAP therapy, but was still highly symptomatic with a high residual AHI. The patient then received a diagnostic attended PSG 4 months prior to his DSA therapy consultation. Sleep study results: overall AHI 27.1, overall RDI = 36.1, REM AHI = 92.1, and supine AHI 39.6. Sleep staging registered as REM sleep of 15.6% TST, N3 of 17.6% TST with a nadir of 76%. The patient's main symptoms include excessive daytime sleepiness, feeling unrefreshed in the morning, and daytime fatigue. Secondary symptoms included frequent heavy snoring and being told by his bed partner that he stops breathing at night. General medical history showed no medical comorbidities, surgical history of general anesthesia, and wisdom teeth removal. The patient sleeps in various sleep positions, sleeps 6–8 h a night, and does not wake up throughout the night. The patient's ESS was 3, with the patient stating that while he is exhausted throughout the day, he can't fall asleep. The patient's main reason for CPAP intolerance is that he feels an increased exhaustion when wearing the CPAP.

16.2.7.2 Clinical Exam

Clinical exam revealed a range of motion of 60 mm for maximum opening, left and right lateral excursions of 10 mm, protrusion of 10 mm, and overjet and overbite of 2 mm. Dental molar classification is Class1 bilaterally (Fig. 16.18), no maxillary or mandibular dental midline deviation with no posterior or anterior open bite. Dental exam showed missing teeth #1, 16, 17, and 32, no mobile/sensitive teeth, no significant attrition, good dental hygiene, no periodontal disease, and no oral prosthetic or night guard currently worn. Palpation of the TMJ and related craniofacial muscles showed no tenderness or pain; cranial nerve exam was negative and no jaw deviation/deflection upon opening and closing with no jaw joint sounds. Tonsils were absent, palatoglossus and pharyngeal walls were Class 2 bilaterally, Mallampati Classification 4, uvula was normal, soft palate was low draping, and gag reflex was normal. Intraoral examination found scalloping of the tongue, a narrowed dental arches, tongue posture above occlusal plane, and gingival inflammation. Cottle maneuver is negative. See Chap. 8 for Cottle maneuver. See Fig. 16.19 for imaging results.

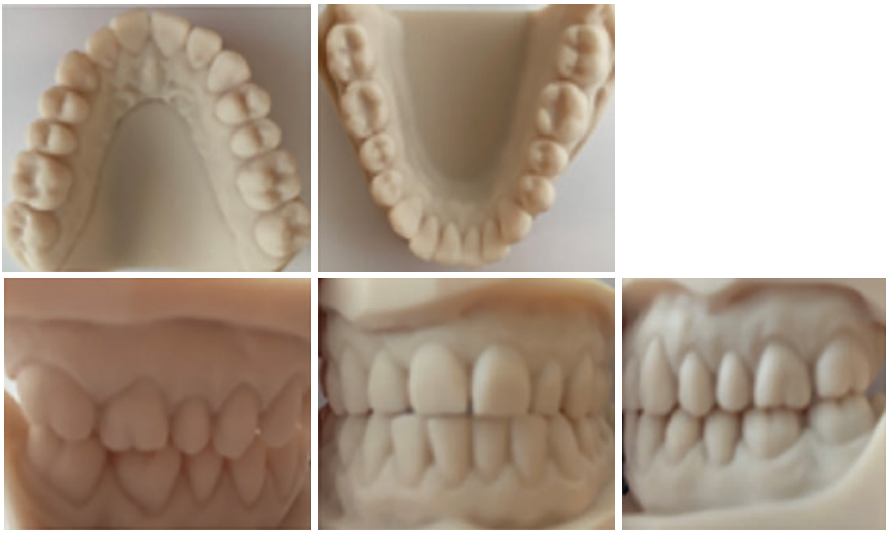

Fig. 16.18 D.M. patient models and occlusion

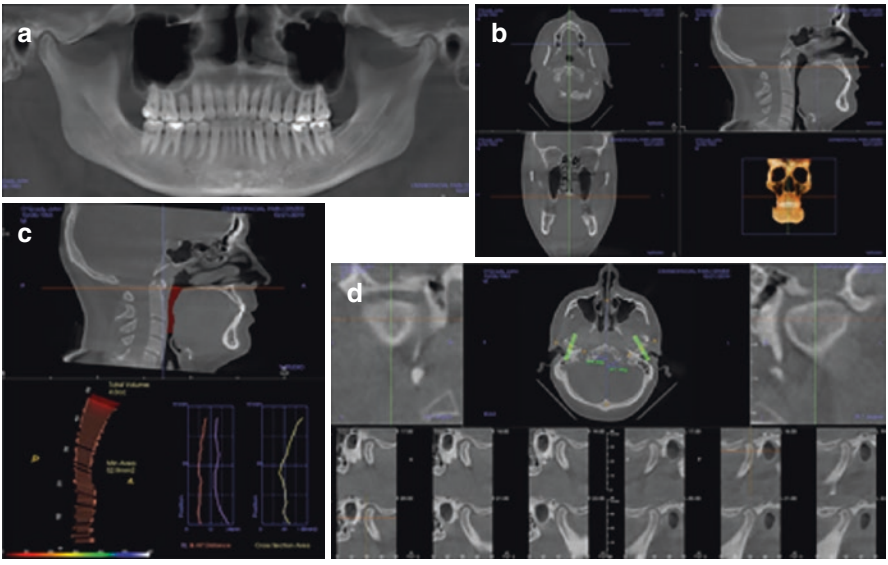

Fig. 16.19 CBCT evaluation: (**a**) The upper left figure is a panoramic radiograph of patient D.M. (**b**) The upper right figure is an overview, but the lateral cephalometric shows narrowed oropharyngeal airway at the base of the tongue. The lower left showing hypertrophy of inferior nasal turbinates. (**c**) The lower left figure shows the lateral view; oropharyngeal airway is shown in red. (**d**) Lateral view of the TMJ, showing bilateral posterior/superior displacement of the mandibular condyles

16.2.7.3 Treatment Recommendation

Custom-fabricated EMA was recommended for this patient due to the narrowed dental arches, minimal space for the tongue, and narrowed oropharyngeal airway at the base of the tongue. The height of the contour is acceptable for the EMA. Refer to an ear, nose, and throat physician (ENT) for suspicion of improper nasal breathing.

16.2.7.4 Treatment

The EMA DSA therapy was started with 21 mm blue EMA bands. During the first recall appointment at 2 weeks, he reported no change in his symptoms.

The patient rated his sleep a 3 on a 1–10 scale, stating that his excessive daytime sleepiness, feeling unrefreshed in the morning, daytime fatigue, frequent heavy snoring, and being told he stopped breathing were the same as before DSA therapy. The patient had occasional soreness of the jaw muscles, which goes away in less than an hour. The patient was titrated to a 19 mm blue band. On the next visit, the patient stated that again, nothing had changed and in fact had gotten worse. The patient noted that his snoring, excessive daytime sleepiness, and feeling unrefreshed in the morning had not changed. The patient did note that his bed partner had not noticed any periods where he stopped breathing. The patient stated that he felt the same as when he was on CPAP, that he is feeling worse with wearing the appliance compared to wearing nothing. The patient was despondent at this juncture. The patient had not had the ENT evaluation as he wanted to first see what results he could gain from DSA therapy. Recommendation was not titration of the DSA and instead was to do a 3-day trial of Afrin to determine the extent that improper nasal breathing could be contributing to the patient's sleep symptoms. At his next follow-up visit 1 week later, the patient stated that there was a "night-and-day difference" with his sleep, stating that his symptoms of excessive daytime sleeping, feeling unrefreshed in the morning, and daytime fatigue had completely resolved during the 3-day trial of Afrin with his bed partner stating that his snoring had dramatically improved as well. The patient was concerned about staying on the Afrin. It was recommended that the patient start using Xlear instead of Afrin for long-term management of his nasal tissue hypertrophy. Additional recommendation was not to titrate from the 19 mm blue EMA bands and to get an efficacy sleep study with the DSA in place.

16.2.7.5 Efficacy Sleep Study

Performed 3.5 months after delivery of the DSA. Overall AHI = 4.9, supine AHI = 5.2, and O_2 nadir of 75%. The patient spent 0.8% of time under an SpO_2 of 88% and 87.2% of time spent in supine sleep.

16.2.7.6 Treatment Recommendations

Discussion with the patient about the ability to continue to titrate as the patient's supine AHI was 5.2. Patient elected to not titrate the appliance as he was sleeping exceedingly well and all of his sleep symptoms that he was seeking treatment for were resolved using the Xlear and DSA. Further discussion of a referral to ENT to evaluate and to determine if the patient is a candidate for nasal surgery. Patient at this point has not followed up with this referral. Patient was placed on a 6-month recall.

16.2.7.7 What to Learn

Daytime fatigue and excessive daytime sleepiness (EDS) can come more from improper nasal breathing than due to OSA in many cases. Always check for improper nasal breathing as this can be a determinant to your DSA therapy results and can make the provider overtitrate a patient when they are chasing symptoms. In this case, the patient's main symptoms and snoring were resolved by addressing the nasal component, while the patient's witnessed apneas were resolved by DSA therapy. It is possible that if the patient's nasal component had been addressed with CPAP use, he would have tolerated CPAP.

16.2.8 Case Study #8: Moderate Sleep Apnea Treated with DSA and Recommendation of Supplemental Oxygen

16.2.8.1 Background

The patient was referred by his sleep physician for evaluation for DSA therapy. The patient had an in-lab PSG sleep study 3 years prior to the evaluation at the request of a different sleep physician. Diagnostic sleep study results showed overall AHI = 21.8/h, overall RDI = 30.4/h, supine AHI 30.4/h, central AHI = 2.4/h, REM RDI = 62.8/h, nadir = 79%, and amount of time under 88% = 9.6 min. The patient elected to have no therapy at that time as he did not want CPAP. The patient was given no other options. Upon presenting to the consultation, the patient's main symptoms he wanted addressed was frequent heavy snoring and night-time choking spells. Secondary symptoms were feeling unrefreshed in the morning and excessive daytime sleepiness, fatigue, headaches, repeated awakenings during sleep, and irritability. Patient medical history showed hay fever for which he took Zyrtec daily. Sleep conditions showed that he slept in varied positions, slept 5 h a night, and woke five times per sleeping. The patient has had his adenoids and wisdom teeth removed. The patient refused CPAP due to claustrophobic associations, leading to his desire to have a consultation for DSA therapy. The patient stated that successful therapy would be for him to stop snoring.

16.2.8.2 Clinical Exam

Clinical exam revealed a range of motion of 49 mm for maximum opening, left lateral excursion of 12 mm and right lateral excursion of 9 mm, protrusion of 8 mm, and overjet and overbite of 2 mm. Dental molar classification was 1 bilaterally (Fig. 16.20), no maxillary or mandibular dental midline deviation with no posterior or anterior open bite. Dental exam showed missing teeth #1, 16, 17, and 32 no mobile/sensitive teeth, no significant attrition, good dental hygiene, no periodontal disease, missing portion of tooth #18 with no active disease, and no oral prosthetic or night guard currently worn. Palpation of the TMJ and related craniofacial muscles showed no tenderness or pain, cranial nerve exam was WNL and no jaw deviation/deflection upon opening and closing with no jaw joint sounds. Tonsils were absent, palatoglossus and pharyngeal walls were a 3 bilaterally, Mallampati Classification of 4, uvula was WNL, the soft palate exhibited loss of tone, and gag

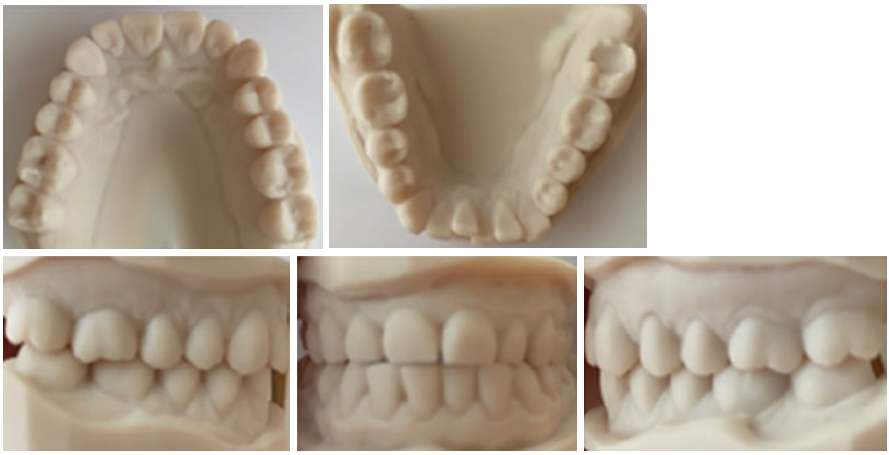

Fig. 16.20 Models of the teeth and occlusion. Notice class I occlusion with anterior crowding and narrowing of the lower dental arch

reflex WNL. Intra-oral examination found scalloping of the tongue, narrowing of the dental arches, tongue posture above occlusal plane, reddened/coated tongue, and gingival inflammation. Cottle maneuver is negative. Please see Fig. 16.21 for imaging results.

16.2.8.3 Treatment Recommendation

It was advised that a custom-fabricated Panthera D-SAD (Fig. 16.22) was a good choice for this patient due to the narrowed dental arches and minimal space for the tongue. Height of contour of the dentition is acceptable for the Panthera and as trying to maximize tongue space. Anterior crowding of teeth did not allow for lingualless appliance design.

16.2.8.4 Treatment

Panthera D-SAD was delivered starting at 25 mm Panthera rods. First recall appointment less than 2 weeks later showed that the patient's symptoms had been improving. Patient rated his sleep a 5 on a 1–10 scale, stating that his frequent heavy snoring was 60% improved, night-time choking spells/witnessed apneas were resolved, and excessive daytime sleepiness had decreased "slightly." Epworth sleepiness score was a 10, initial was 11. We decided to titrate the Panthera 2 mm, changing the rods from 25 to 23 mm rods. While the patient was scheduled for a 2-week follow-up visit, he did not come in for 8 weeks. During this time, he had decided to go back into the sleep physician's office to get a sleep study to "check on how things are going" without informing our office. The patient was now rating his sleep as a 7 (on a scale of 1–10), while stating that his snoring was resolved, night-time choking spells/witnessed apneas were resolved, excessive daytime sleepiness was 40–50% improved, and feeling unrefreshed in morning was 50–60% improved. The patient had no inherent concerns about his sleep at this time and was pleased that his snoring was resolved.

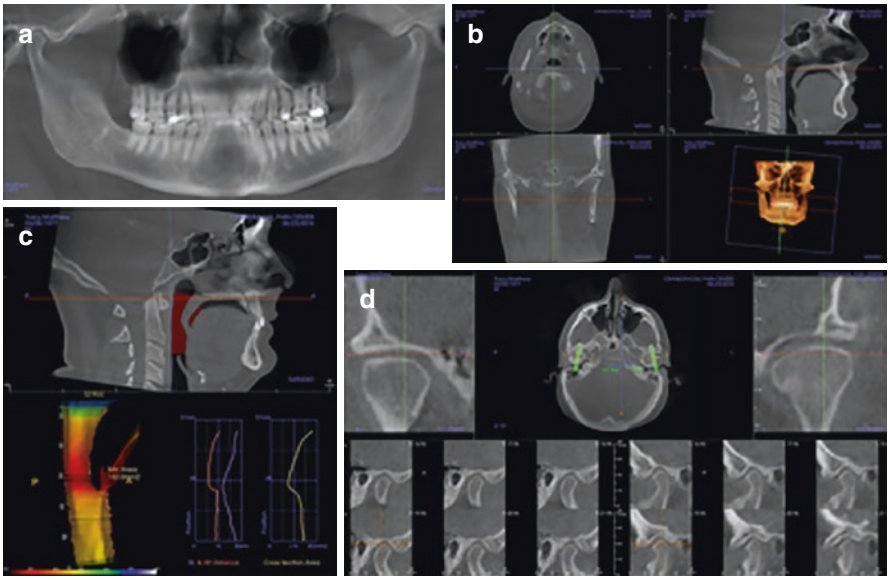

Fig. 16.21 (**a**) Upper right figure, panoramic view. (**b**) Upper left figure, CBCT overview. (**c**) Lower left figure, CBCT evaluation indicates a narrowed oropharyngeal airway posterior to inferior soft palate. (**d**) CBCT, tomographic view indicates posterior/superior displacement of bilateral TM condyles

Fig. 16.22 Panthera D-SAD. (Figure courtesy of Apex Dental Sleep Lab)

16.2.8.5 Efficacy PSG Sleep Study

Performed 1.5 months after delivery of the DSA. Overall AHI = 5, supine AHI = 6.4, REM AHI = 15.9, O_2 nadir of 78%, and time below 89% = 107.0 min. Patient's sleep architecture showed 12.3% N3 and 23.2% REM sleep.

16.2.8.6 Treatment Recommendations

Sleep physician recommendations were to continue with DSA therapy while adding supplemental oxygen considering the low-oxygen desaturations that were continuing despite reduction in OSA events. Patient declined supplemental oxygen as his main symptom of snoring had been resolved.

16.2.8.7 What to Learn

Communication is imperative. The patient and sleep physician had both been told that we would refer for the follow-up sleep study once we had determined that maximum medical improvement (MMI) had been reached. While the patient's main symptom had been resolved, his secondary symptoms had only improved. Most of the time, we only get one chance for the patient to get an efficacy sleep study with the DSA before they decide not to continue with tests. We should make sure that they have truly reached subjective efficacy. While many would look at this case as a moderate success, I view it as a failure. We had one shot to improve all the parameters on this patient and to verify it with a sleep study. Unfortunately, after the patient saw that his numbers went down and that his snoring was resolved, he was resistant to continue to titrate. While this patient is very happy with therapy, I feel we could have done more to improve supine AHI and oxygen desaturations.

16.2.9 Case Study #9: Noncompliant CPAP Patient with Moderate OSA and TMD Present Treated with DSA, Nasal Surgery, and Supplemental Oxygen

16.2.9.1 Background

The patient was referred by a previous patient for evaluation for DSA therapy. The patient had an in-lab split night sleep study 7 months prior to the evaluation. Diagnostic sleep study results showed overall AHI = 27.1, overall RDI = 32.7, supine AHI = 13.3, non-supine AHI = 50.6, REM RDI = 107.4, and O_2 nadir of 70%. During the second part of the night, where the patient underwent CPAP titration, the OSA was controlled with a CPAP pressure of 5 cm H_2O. Upon presenting to the consultation, the patient's main symptom she wanted addressed was feeling unrefreshed in the morning and daytime fatigue, while secondary symptoms included headaches and chronic sinusitis. Patient medical history showed chronic fatigue, difficulty concentrating, dizziness, fainting, fluid retention, frequent colds/flu, frequent cough, hearing impairment, insomnia, irregular heartbeat, osteoarthritis, ovarian cysts, recent weight gain, sinus problems, swollen/stiff/painful joints, and prior orthodontics. Sleep conditions showed that she slept in a side position, slept 8 h a night, and woke 1–2 times per sleep period with an Epworth sleepiness score of 4. The patient has had her wisdom teeth extracted and oral surgery. The patient refused CPAP therapy due to disturbed or interrupted sleep caused by the presence of the device, CPAP-restricted movements during sleep, discomfort caused by the straps/headgear, latex allergy, and claustrophobic associations. These were all reasons that were experienced during the CPAP titration portion of the sleep study.

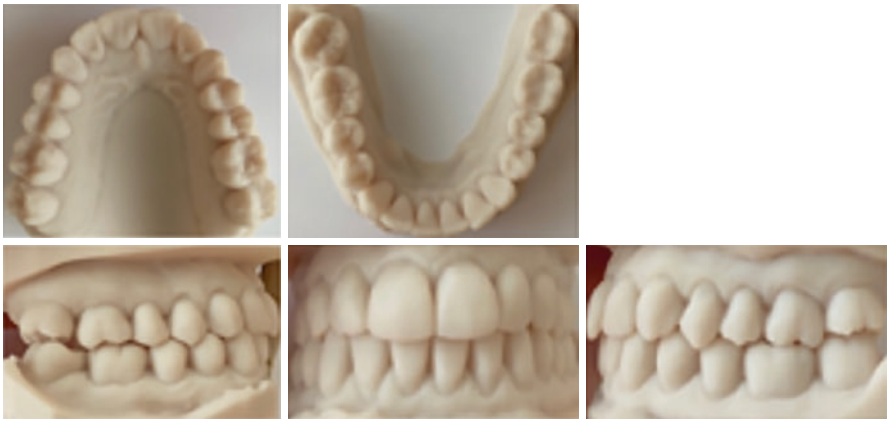

Fig. 16.23 Patient models and Class I occlusion

16.2.9.2 Clinical Exam

Clinical exam revealed a range of motion of 55 mm for maximum opening, left lateral excursion of 10 mm and right lateral excursion of 10 mm, protrusion of 5 mm, and overjet and overbite of 2 mm. Dental molar classification was 1 bilaterally (Fig. 16.23), no maxillary or mandibular dental midline deviation with no posterior or anterior open bite. Dental exam showed missing teeth #1, 16, 17, and 32, no mobile/sensitive teeth, no significant attrition, good dental hygiene, no periodontal disease, and no oral prosthetic or night guard currently worn. Palpation of the TMJ and related craniofacial muscles showed no tenderness or pain; cranial nerve exam was normal and jaw deviation of 2 mm to the left upon opening and TMJ click on the left side upon opening. Tonsils were absent, palatoglossus and pharyngeal walls were a 3 bilaterally, Mallampati Classification of 4, uvula was WNL, soft palate exhibited loss of tone, and gag reflex was normal. Intra-oral examination found scalloping of tongue, narrow dental arches, tongue posture above occlusal plane, reddened/coated tongue, and gingival inflammation. Cottle maneuver is negative. For imaging results, see Fig. 16.24.

16.2.9.3 Treatment Recommendation

It was advised that a custom-fabricated Panthera D-SAD be considered for this patient due to the narrowed dental arches and minimal space for the tongue. The height of contour of the dentition is acceptable for the Panthera as the maximum tongue space and would be achieved due to limited protrusion. Referral to a local ENT was initiated at this appointment.

16.2.9.4 Treatment

The patient was fitted with the Panthera D-SAD and was started on 27 mm Panthera rods. At first recall appointment 4 weeks later, it showed that the patient's symptoms had improved. The patient rated her sleep a 6 on a 1–10 scale, stating that her feeling unrefreshed in the morning was 50% improved, her general fatigue

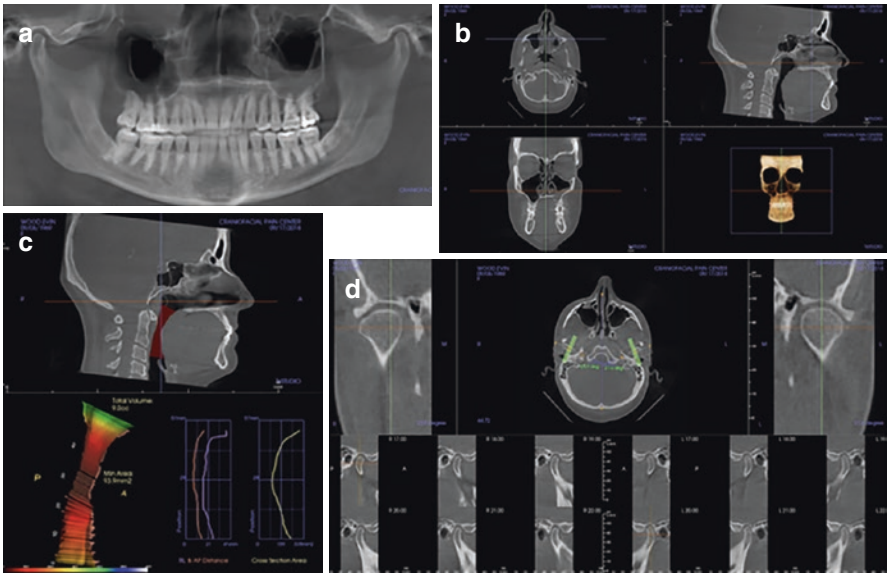

Fig. 16.24 (**a**) The upper left figure is a panoramic overview. (**b**) Upper right figure, notice the left sinus inflammation. (**c**) Lower left, lateral view of oropharyngeal airway is indicated in red. (**d**) Lower right figure, tomography indicates temporomandibular condyles displaced posterior and superior the cranial fossa

was 50% improved, and headaches were 98% improved; however, her sinusitis was the same. Epworth score was a 6, initial was 4. The patient informed us that she had gone to the ENT and that nasal turbinate surgery had been scheduled in less than 2 weeks from this follow-up visit. We decided to titrate the Panthera by 2 mm, changing the rods from 27 to 25 mm rods. The patient was scheduled for 6 weeks out due to her nasal surgery and recovery time period. At the second follow-up visit, the patient stated that her sleep had slightly worsened than from her previous visit and that she was a little more tired. The patient wanted to go back to the initial band setting of 27 mm as she felt better at this position. The DSA was advanced by 1 mm of the appliance from a 25 to 24 mm rod. The patient's next follow-up was 6 weeks after the second follow-up visit. At this point, the patient stated that her sleep was a 7 (on a scale of 1–10). She rated her feeling unrefreshed in the morning as 70–80% improved, her fatigue was 70% improved, headaches were resolved, and chronic sinusitis was significantly improved. Her husband stated that he no longer noticed "weird breathing." At this point, an effective sleep study with the DSA was advised.

16.2.9.5 Efficacy PSG Sleep Study

Performed 6 months after delivery of the DSA. Overall AHI = 3.1, supine AHI = 2.5, non-supine AHI = 3.9, REM AHI = 3.2, and nadir = 77%. The patient's sleep architecture showed 26.8% REM sleep.

16.2.9.6 Treatment Recommendations

Sleep physician recommendations were to continue to wear the DSA and to be supplemented with oxygen due to some transient desaturations and a nadir of 77%. The patient followed through with this decision and started oxygen.

16.2.9.7 Follow-Up to Efficacy

The patient missed her 2- and 6-month recall visits. The patient called in 1 month after to state that she just started having severe jaw pain in her right side that lasted all day. The patient had taken multiple medications that were not helping her. The patient stopped wearing the appliance for a few days due to the jaw pain, but her sleep worsened significantly to the point she decided it was "worth it to deal with the pain." The patient was scheduled for a recall appointment. The patient was despondent at the thought she could no longer be a "candidate" for DSA therapy. Palpation of the craniofacial muscles, tendons, and joints showed severe pain in the (R) temporal tendon, (R) TMJ posterior joint space, and (R) TMJ lateral capsule. It was discussed that a different appliance might be needed that would afford her more lateral movement as she could have started some parafunctional activity. However, it was determined that the vertical could be excessive at this point for the patient's craniofacial structures and that some parafunctional activity at nighttime could have exacerbated this. The vertical was reduced on the appliance by 3 mm in the anterior. The patient stated that it felt less stressful on the patient's muscles. We decided to try this first before changing appliances. At the patient's next appointment and at the following 6-month recall, she continued to be stable at this position with no jaw pain and great sleep with the DSA and supplemental oxygen.

16.2.9.8 What to Learn

There are multiple take-away points from this case. First was during titration. It was likely the patient's sleep would worsen after nasal surgery for a period of time, depending on the surgery and surgeon, up to 6–8 weeks. Therefore, while the natural reaction would have been to return the patient to the 27 mm position, the DSA was titrated forward 1 mm to the 24 mm rods. Had she stayed at the 27 mm position, she would have felt better, but it would only have been because she was fully healed from the nasal surgery, giving us a false improvement. Second and maybe more important is that we cannot always just look at the AHI on an efficacy sleep study. The patient's AHI greatly reduced across all parameters, most notably her AHI during REM sleep. However, she still has a nadir of 77%. Supplemental oxygen was a good determination for the patient. This is also a very good example of why a dentist should not be performing these sleep studies. Many dentists would have missed this. The qualified physician who performs and reads the sleep study should be making the treatment recommendations, with input from the dentist when it comes to DSA therapy. Finally, this case shows that our work is not done once we have a good outcome for a patient. Recall appointments are imperative as patient's change dramatically through life. This patient had been exceedingly good for over 1.5 years at a current position until 1 day. Recall appointments should be done over the life of the patient as long as they are wearing the DSA. Finally, many times we are quick

to throw out a device when we aren't getting the result that we want. While a different device would have probably worked for the patient, evaluating the jaw, deciding the problem, and making a clinical decision to reduce the vertical on the appliance ended up being the answer. Knowledge of the TMJ and craniofacial pain is imperative to proper DSA therapy treatment.

16.3 Synopsis

Several attempts have been made to show different cases in which DSAs were used to treat patients. Many of these patients were CPAP intolerant and relying on another avenue for their OSA treatment, but some of the patients chose the DSA as the first line of sleep apnea therapy. Several of the cases got superior results with just the DSA therapy, but in other instances, supplemental treatments were either suggested or implemented to help with the DSA therapy. This statement should bring to the reader's attention that any dentist who desires to practice dental sleep medicine needs to have a good education and understanding of the anatomy, terminology, and physiology of the upper airway. The dental profession should be grateful for the many researchers who have studied this field for the usage and outcomes of DSA therapy and have held controlled studies to debunk the feeling by many of our medical colleagues that "oral devices don't work." Evidence has proven that DSA therapy is an effective treatment for OSA.

A recent publication by the AADSM is titled Dental Sleep Medicine Standards for Screening, Treating and Managing Adults with Sleep-Related Breathing Disorders. This article outlines the steps that each dentist should go through when assessing the patient. These steps, if followed, will enable the dentist to look at each patient objectively and thoroughly when examining the patient and look at all the pertinent factors in treating the patient [37].

Hopefully, the book has helped to excite the dentist to get involved in the treatment of sleep apnea in their office, as it has been gratifying to help patients with OSA and underlying comorbidities.

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