(b) How Does the Airway Lend Itself to Therapy?

Can We Predict the Success of Dental Appliance Therapy for the Treatment of Obstructive Sleep Apnea Based on Anatomic Considerations?

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Traditional cephalometrics (1-3), though having the limitation of any two-dimensional (2D) method, has several advantages, including low cost, easy access and reduced invasiveness. Although computerized tomography (CT) has many advantages as a measuring tool for three-dimensional (3D) airway size (4-8), it is time consuming and expensive for routine clinical use. However, 3D color reconstructions of the tongue, oropharynx and hypopharynx (9,10) provide more realistic views of each of the tissues under study and are ideal for detailed interpretations of the interaction between tongue, airway and soft palate size (Fig. 1). There appears to be a strong linear relationship between 2D cephalometric and 3D CT reconstructions for the tongue, soft palate and nasopharynx, but not for the oropharynx and hypopharynx (10). Approximately 40% of the variation of tongue volume can be explained by tongue cross-sectional area. The oropharynx and hypopharynx have no direct hard tissue support and the configuration of these structures appears to be less consistent. The posture of the head and neck, swallowing and glottic closure (11,12) may also affect cephalometric and CT measurements. Furthermore, CTs are taken in supine position, whereas traditional lateral cephalograms are obtained in the standing position. Different body postures may be a crucial factor affecting these measurements. To solve this problem, cephalograms should be obtained from OSA patients in a supine position identical to that used for CT evaluations (2).

We believe that 2D cephalograms can be used to estimate the volume of the tongue, soft palate and nasopharynx but not the volume of the oropharynx or hypopharynx (10). Because the airway obstruction is most commonly seen in the collapsible oropharynx, CT or magnetic resonance imaging (MRI) techniques appear superior to 2D cephalometry for this structure. Three-dimensional evaluations of tongue, soft palate and airway as shown in Fig. 1 may be of significant clinical usefulness in the differential diagnosis of patients with OSA.

DENTAL APPLIANCE THERAPY

Documented before-and-after appliance insertion comparisons have been completed for some 500 subjects with obstructive sleep apnea (OSA) (13). Dental appliance therapy for snoring and/or OSA is simple, reversible, quiet and cost effective and may be indicated in patients who are unable to tolerate nasal continuous positive airway pressure (CPAP) or who are poor surgical risks. Two general types of appliances are particularly effective in the reduction of OSA (13): those that reposition the mandible [the traditional mandibular repositioner (8,14), the Herbst (15), the NAPA appliance (16), the SNOAR appliance (17) and the Snore Guard (18)] and those that change the position of the tongue [Tongue Retaining Device (19)].

With one type of mandibular repositioning appliance, Meier-Ewert and Brosig (14) reported an apnea index (AI) reduction from 50.4 to 23.1 in a sample of 44 subjects. Using 3D tongue and airway reconstructions, Lowe et al. (8) documented a 27.6% increase in partial airway volume from 12.3 to 15.57 cc after the insertion of a mandibular repositioner. A marked anteroposterior elongation of the total airway tube was also observed, and the oropharynx widened in the anteroposterior plane. In 15 subjects who underwent sleep studies before and after Herbst appliance insertion (15), oxygen desaturation levels improved markedly and the respiratory distress index (RDI) decreased from a mean of 48.4 to 12.4 4 months after insertion. The Nocturnal
Airway Patency Appliance (NAPA) (16) incorporates an oral breathing beak and also has been shown to be effective. The Sleep and Nocturnal Obstructive Apnea Reducer (SNOAR) (17) opens the vertical dimension, and a mean RDI of 45.5 was reduced to 9.7. After 7 months of prefabricated Snore Guard (18) use in 68 patients, 75% of the individuals used the appliance regularly. In 20 OSA subjects, before and after polysomnography revealed a mean RDI decrease from 47.4 to 19.7, and oxygenation and sleep disturbance were improved.

The Tongue Retaining Device is designed to hold the tongue forward during sleep. When the traditional 50% reduction in RDI was used as the index of successful treatment, 73% of the TRD group and 80% of the TRD plus posture alarm group were successful (19). The 15 subjects treated with the TRD alone had a reduction in mean RDI from 27.4 to 11.4. Patency of the nasal airway and an initially low side index were the two factors significantly related to the successful control of OSA with the TRD. For the 15 subjects in the TRD plus posture alarm group, lower initial obesity and higher weight loss during treatment were the factors associated with the best success. A mean RDI reduction from 30.7 to 7.9 (the lowest of all reported studies) was seen for the latter group.

Dental appliances are effective in varying degrees and appear to work due to an increase in airway space, the provision of a stable anterior position of the mandible, the advancement of the tongue and/or soft palate and possibly by a change in genioglossus muscle activity. The selection of which patients are potentially suitable for dental appliance therapy must always be made by the attending physician. The usefulness of dental appliances for the effective treatment of snoring and/or OSA is no longer in question. Only their correct management and supervision requires clarification. If the initial assessment is coordinated by the attending physician and good communication is established with the dentist involved, a significant number of subjects with snoring and/or OSA can be effectively treated with a dental appliance. Unfortunately, at the present time it appears that we cannot predict with a significant degree of accuracy the potential success of any one dental appliance based on anatomic considerations alone. Future development of clinically accessible and

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FIG. 1. Three-dimensional CT reconstructions of the posterior view of two subjects with OSA. The mandible is shown in white, the tongue in red, the airway in blue, the masseter muscle in pink and the medial pterygoid muscle in orange. Both patients have similar tongue volumes and apnea indices but their airway morphologies are significantly different.
inexpensive 3D analyses may alleviate this problem in the future.

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REFERENCES


DISCUSSION OF THE ARTICLE

D. White: In your mind in terms of deciding between a tongue retaining device and a mandibular advance, what is the best way to proceed?

A. Lowe: With our data base, we can do it based on comparing the patient's tongue volume to our three-dimensional tongue volume database, which is not a diagnostic test available in all countries. But cephalometric measurements of tongue size are good indicators of tongue volume. Subjects with large tongues tend to get tongue retaining devices. Patients with obvious retrographic mandibles tend to get mandibular advancement appliances.