ELSEVIER

Seminars in
ORTHODONTICS

Masticatory Muscle Exercise as an Adjunctive Treatment for Open Bite Malocclusions

Jeryl D. English and Kamrin D.G. Olfert

The article distinguishes between dental open bite and skeletal open bite malocclusions and reviews the etiologic factor and possible treatment options. The addition of light masticatory muscle exercise on two mixed detention cases is illustrated. The patients were treated with a bonded rapid palatal expander followed by a transpalatal arch and a mandibular lingual arch, high-pull headgear therapy and light masticatory muscle exercises for 1 minute five times per day. A third case illustrates an increase in the clenching exercises of at least 5 minutes per hour for 6 hours. This patient had changed her mind on orthognathic surgical treatment plans. Treatment results suggest that clenching exercises helped to control the vertical dimension and assist in closure of open bite malocclusions. More clinical research is required to ensure the optimum level of masticatory muscle exercise for the treatment of open bite malocclusions.
Semin Orthod 11:164–169

Open bite is defined as the lack of vertical overlap of the anterior teeth in centric occlusion.[1,2] An open bite of greater than 2 mm occurs in less than 1% of the population and has five times greater prevalence in the black population than in the white or Hispanic populations.[3] Generally two forms of open bite can be distinguished: dental and skeletal open bites. Dental open bite occurs when the abnormalities are confined to the dentoalveolar region. This type is usually related to environmental factors, such as thumb sucking, and can be treated successfully by orthodontic treatment alone. The prognosis of a dental open bite is favorable, provided the environmental factor can be controlled. The second type of open bite is skeletal open bite, which occurs when the patient has an open bite that is not limited to the dentoalveolar region, but the etiology lies in the underlying skeletal structure of the jaws. In skeletal open bites, the etiology may be related to the vertical facial form as a result of excessive vertical growth. This skeletal pattern has been described as long-face syndrome,[4] high-angle case,[5] or hyperdivergent growth pattern.[6] Skeletal open bites tend to have greater molar and incisor eruption whereas dental open bites are a result of intrusion of anterior teeth.

Department of Orthodontics, Dental Branch, University of Texas Health Science Center at Houston, Houston, TX.

Address correspondence to Jeryl D. English, DDS, MS, Department of Orthodontics, #370, Dental Branch, University of Texas Health Science Center at Houston, 6516 MD Anderson Blvd, Houston, TX 77030. Phone: 713-500-4119; Fax: 713-500-4123; E-mail: Jeryl.D.English@uth.tmc.edu

The differentiation between dental and skeletal open bites can be difficult to distinguish clinically. Age of the patient and the presence of a habit are important considerations when examining a patient. In 1984, Cangialosi[7] developed a cephalometric analysis to determine what constitutes a skeletal open bite. If 4 of the 6 cephalometric measurements (ratio of posterior to anterior facial height; ratio of upper to lower facial height; SN-GoGn, gonial angle, SN-PP, PP-GoGn) recorded were within one standard deviation from the norm and the remaining two were between one and two standard deviations from the norm, the open bite was considered to be dentoalveolar in nature. Nahoum[8] based his diagnosis on the ratio of upper anterior facial height to lower anterior facial height (UAFH:LAFH). If a patient had an open bite and a UAFH:LAFH ratio of less than 0.65, then the open bite was considered skeletal and could not be corrected by orthodontic treatment alone. Although there appears to be no concrete formula or singular measurement that can be used to diagnose skeletal open bites, most authors agree that they have some of the following characteristics: increased mandibular plane angle, increased lower facial height, increased total facial height, decreased posterior facial height, tipping of the palatal plane, and a retrognathic mandible.[9,10]

It is generally accepted that excessive vertical growth is an etiology of skeletal open bites.[11] However, what causes the skeletal vertical growth remains in question. Heredity plays an important role in the development of the orofacial complex. Parents who have high mandibular plane angles and vertical growth pattern may pass their traits on to their children. A digit habit that is present for an extended period of

 1073-8746/05/$-see front matter
doi:10.1053/j.sodo.2005.04.010

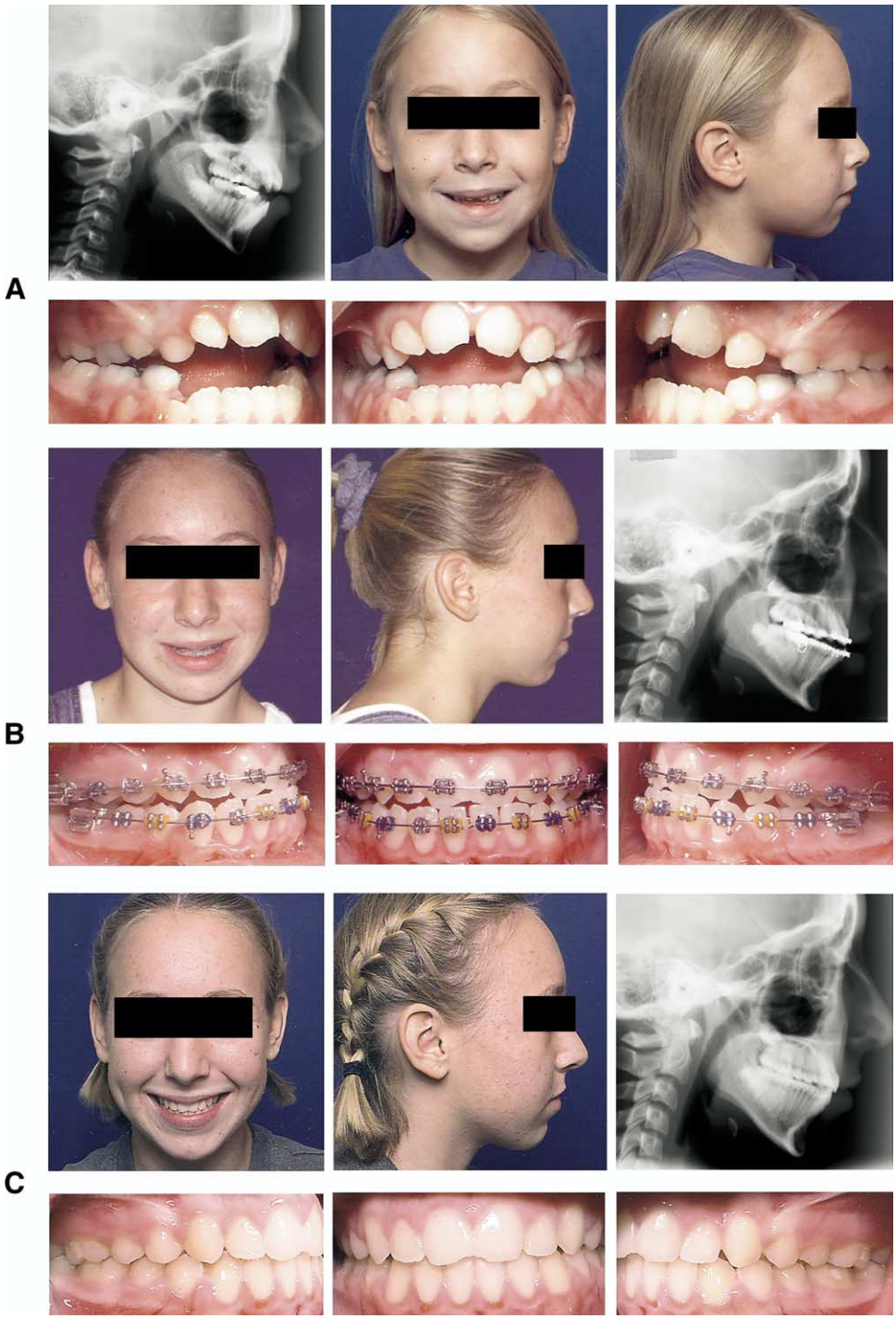

Figure 1 Records for Patient 1. (A) The first set of records are the pretreatment records for the female at age 9 years 1 month. (B) The second set is at the beginning of phase II treatment; age 12 years 9 months. (C) The final records were taken at age 13 years 11 months.

time could alter growth similar to a functional appliance and accentuate the vertical aspect of growth. Airway obstruction has also been implicated in the cause of open bite.[11] The thought is that enlarged adenoid tissue causes restriction in the airway, forcing the tongue anteriorly, which in turn causes skeletal and dental open bite problems. These growth changes include rotation of the mandible downward and backward in a clockwise direction.[11] According to Proffit,[12] tongue thrusting is considered the result of displaced incisors and not the cause of the tongue posturing.

The treatment of the skeletal open bite continues to challenge contemporary orthodontists. In a recent study, Iscan[13] reported successful correction of skeletal open bites by using vertical chincaps. The chincaps successfully inhibited the vertical growth of the mandibular posterior dentoalveolar region, resulting in an anterior rotation of the mandible.

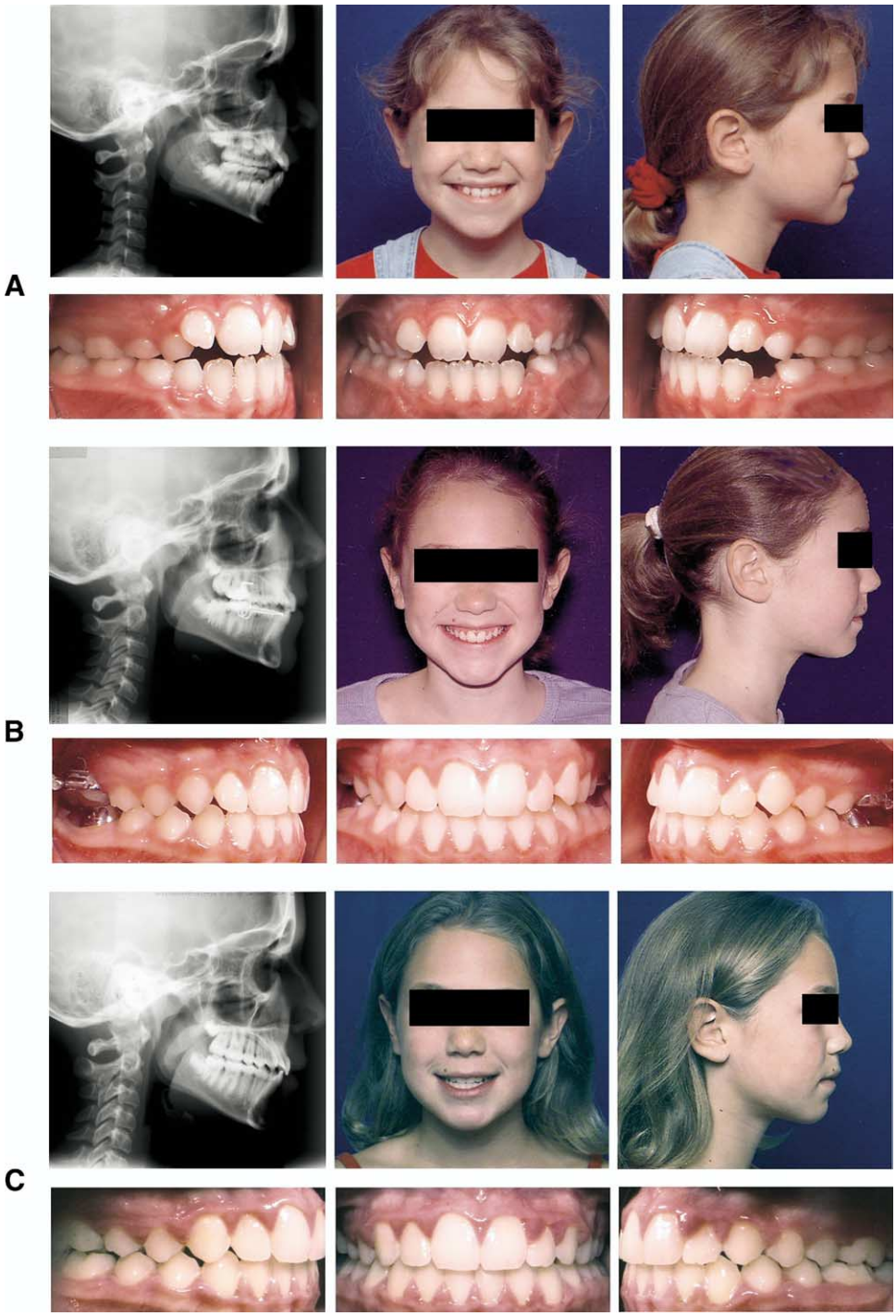

Figure 2 Records for Patient 2. (A) The first set of records are the pretreatment records for the female at age 8 years 9 months. (B) The second set is at the beginning of phase II treatment, age 10 years 7 months. (C) The final records were taken at age 12 years 0 months.

Kuster and Ingervall[14] reported using two types of bite blocks, spring loaded and magnet repelling, to treat open bites in growing patients. The authors reported an improvement of 1.3 mm of anterior open bite with the spring-loaded bite blocks and a 3-mm improvement with the repelling magnet bite block. However, the beneficial effects of the bite block had a tendency to relapse.

Once growth is complete, clinicians cannot utilize growth modification to address the skeletal problem. Many procedures and types of mechanics have been developed, and most of the procedures are designed to intrude the posterior teeth in an attempt to reduce or control anterior facial height. Unfortunately, most (if not all) of these procedures produce changes in the dentoalveolar region to compensate for the skeletal problem. The many nonsurgical options include anterior vertical elastics, posterior bite blocks, high-pull head-

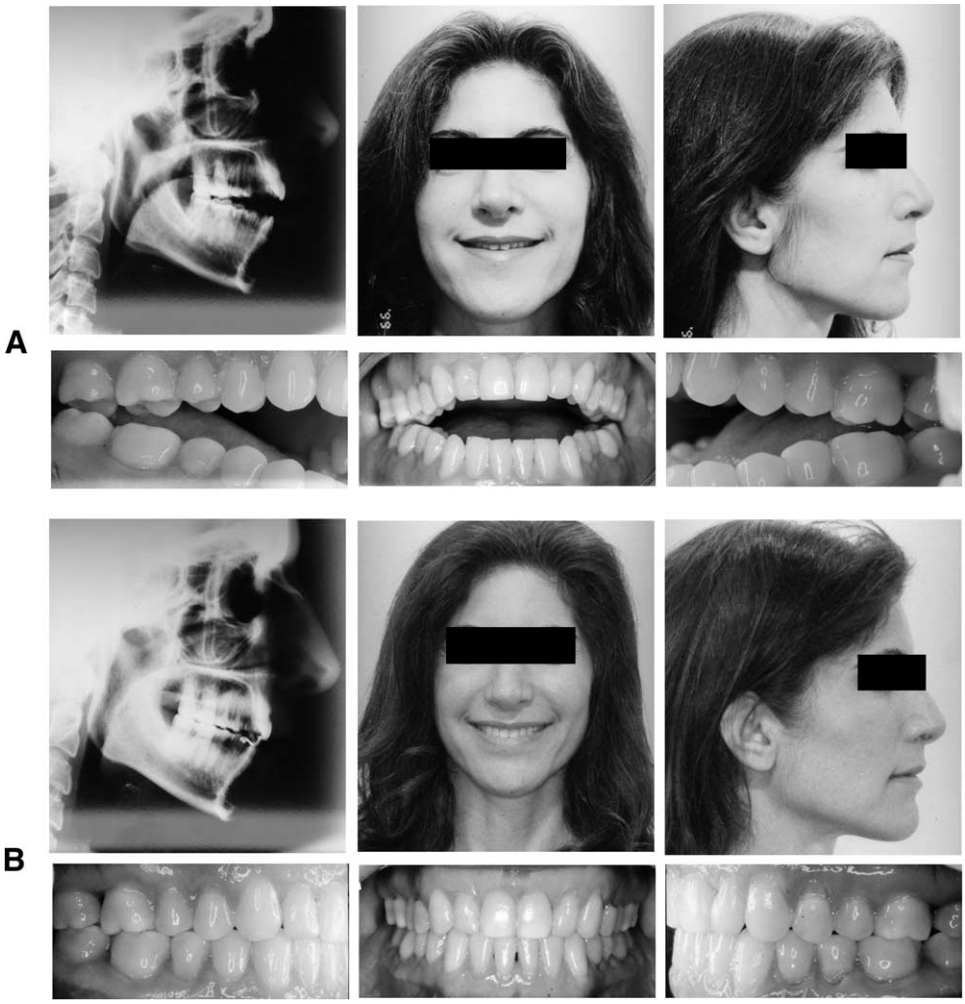

Figure 3 Records for Patient 2. (A) The first set of records are the pretreatment records for this female adult patient. (B) The final records were taken at the completion of treatment.

gear, vertical pull chincaps, and implants. Nonsurgical options usually require longer treatment time and more patient compliance.[15] Titanium miniplates have gathered popularity recently in the treatment of open bite. Sherwood and coworkers[16] in 2002 obtained a mean molar intrusion of 2 mm and closure of the incisors by 3.6 mm by using titanium miniplates in the maxilla. Umemori and coworkers[17] in 1999 obtained intrusion of the mandibular molars by 3 to 5 mm by using titanium miniplates. A recent study by Sugawara et al[18] showed intrusion of the mandibular first and second molars by 1.7 mm and 2.8 mm, respectively. The average relapse rates were 27% in the first molars and 30% in the second molars. Severe skeletal open bites in nongrowing patients are best treated with a combined orthodontic-surgical approach. A Le Fort I osteotomy with superior repositioning of the maxilla is indicated for patients with excessive vertical maxillary growth. The superior repositioning allows for the counterclockwise rotation of the mandible and resultant decreased lower face height and elimination of the open bite. Opdebeeck and Bell[19] stated: "Vertical dysplasias, however, are difficult to describe within the framework of traditional anteroposterior classifications. In addition, such dysplasias are in many cases associated with, and may indeed be at the origin of, anteroposterior dysplasias." It is because of this relationship that many skeletal open bite cases will also require a mandibular advancement procedure to correct the retrognathic mandible. A combined surgical-orthodontic approach still remains as the treatment of choice for skeletal open bites. Unfortunately, surgery is not always a valid option for the patients. Insurance companies have become more reluctant to approve orthognathic surgery, and hospital costs are rising. The objective of the present article is to propose a novel approach in the treatment of anterior open bite.

In a prospective cephalometric study, the combined effect of a bonded rapid palatal expander (RPE) followed by a transpalatal arch and a mandibular lingual arch, high-pull headgear therapy and light masticatory muscle exercises on the craniofacial morphology of skeletal open bite patients was evaluated.[20] Thirty-one patients were treated with a bonded rapid palatal expander that was fabricated to exceed the freeway space by 2 to 3 mm and act as a posterior bite block. The expansion appliance was turned one turn per day (1/4 mm) until the maxillary molars approached a buccal crossbite. The transverse dimension was stabilized with the expansion ap-

pliance for 3 months. After the RPE was removed, a transpalatal arch (TPA) was placed to maintain the intermolar width. An acrylic button (15 mm in diameter) was placed on the TPA in the middle of the palate, approximately 2 to 3 mm off the palatal tissue. Patients were instructed to wear a high-pull headgear for at least 12 hours per day. The force delivered was approximately 500 g per side. To maintain the mandibular arch length and avoid molar extrusion, a fixed lingual arch was placed and remained throughout the treatment time. The mean age of the patients was 9.3 ± 1.3 years and the average treatment time was 23 ± 4.7 months. After completion of expansion, subjects were randomly assigned to either an exercise or nonexercise group. Patients in the exercise group were instructed to clench on a soft bite wafer for 1 minute, five times a day. Each 1-minute session included 5 seconds of isometric clenching (80% of maximum), followed by 5 seconds' rest, and repeated six times for a total of 1 minute. The exercise was repeated five times a day. Morphological data were derived from pre- and posttreatment lateral cephalograms. Lateral cephalograms of untreated subjects that were matched by age, sex, and mandibular plane angle were used as the control group. These patients were selected from the files of the Baylor College of Dentistry, Department of Orthodontics. Maximum and submaximal bite forces, together with associated masseter muscle activity, were recorded before and after exercise training. The linear relationship between electromyographic (EMG) activity and bite-clenching exercises helped to control the vertical dimension. High-pull headgear therapy alone increased overbite and had an intrusive effect on the maxillary molars. Exercise in combination with high-pull headgear produced significant reductions in the ANB (average −0.9°) and gonial angles (average −1.3°) and mandibular autorotation (average 2.2°). As with any compliance-related regimen, treatment results will vary with patient cooperation. Maximal bite forces and EMG/force slopes showed no significant group differences. Although isometric clenching exercises did not strengthen masticatory muscles, its effects on facial morphology may help to reduce aberrant vertical growth patterns.

The following questions are frequently asked by clinicians using this technique and we have included a few case reports illustrating treatment results.

Does the Masticatory Exercise Have an Effect on Patients with Open Bite Malocclusions?

The results of the preliminary study suggest that isometric exercises in combination with a high-pull headgear have a positive effect by facilitating autorotation, decreasing ANB, and closing the gonial angle in the mixed dentition. Although exercise training did not strengthen masticatory muscles, its effects on facial morphology may help to reduce aberrant vertical growth patterns.

What Is the Duration of the Exercise?

Patients were instructed to clench on a soft bite wafer (GAC International, Bohemia, NY) for 1 minute, five times a day. Each 1-minute session included 5 seconds of isometric clenching (80% of maximum), followed by 5 seconds' rest. This cycle was repeated six times, for a total of 1 minute.

Would This Treatment Technique Be Beneficial to All Types of Cases?

The exercise regimen is beneficial for both skeletal open bites (orthopedic effect) and dental open bites (orthodontic effect). It would not be beneficial in open bite cases where the etiology lies in the condyle, that is, idiopathic condylar resorption or rheumatoid arthritis. In the case where the open bite is a result of primary failure of eruption, the exercises would also be of no benefit.

Would This Technique Be Helpful in Retaining the Correction of the Open Bite?

Yes! Positioners have been long been regarded as the retainer of choice for open bite malocclusions. The clenching exercises would have a positive effect, aiding in retention and in prevention of the open bite relapse.

Would This Technique Be Harmful to the TMJ?

No, temporomandibular disorder is primarily a result of parafunctional habits, not a conscious exercise program.

Case Reports

Patient 1 (Fig 1), a female, age 9 years 1 month, with an open bite malocclusion, presented to the clinic with a chief complaint of "crooked anterior teeth." A bonded RPE was placed that exceeded the freeway space by 3 mm. The patient was instructed to turn the jackscrew one turn per day (1/4 mm/day). Once the maxillary molars approached buccal crossbite, the expansion screw was tied off, and the RPE was left in place for 3 months. On removal of the RPE, a transpalatal arch with an acrylic button (15 mm diameter, 3 mm off of the palatal tissue) was placed to maintain the intermolar width. A high-pull headgear was fitted to deliver 500 g per side, and the patient was instructed to wear the headgear for 12 hours per day. A fixed lingual arch was placed, and instructions were given for the masticatory exercises. The exercise regimen was continued for 1 year. Full phase II treatment began at age 12 years 9 months and completed at age 13 years 11

months. The SN-MP angle was 52.5° pretreatment and 44.8° posttreatment, resulting in a decrease of 7.7°.

Patient 2 (Fig 2), a female, age 8 years 9 months, with an open bite malocclusion, presented to the clinic with a chief complaint of crossbite. The same treatment regimen was used as for Patient 1. Full phase II treatment began at age 10 years 7 months and was completed at age 12 years 0 months. The SN-MP angle was 34.5° pretreatment and 31.8° posttreatment, resulting in a decrease of 2.7°.

Patient 3 is an adult patient with an open bite malocclusion who decided against an orthognathic surgical treatment plan (Fig 3). She was asked to significantly increase the amount of time per day devoted to a masticatory muscle exercise regimen originally proposed by one of the authors (J.E.) in the prospective mixed dentition study of open bite malocclusions. This patient was asked to "clench" her teeth on the bite wafer for as much time as she could, but at least 5 minutes per hour for 6 hours as a minimum. She was extremely compliant with the clenching exercises. The SN-MP angle was 37.7° pretreatment and 33.5° at the completion of treatment, resulting in a decrease of 4.2°.

Conclusions

Skeletal open bite treatment is difficult and, unless the surgical route is taken, relapse is a significant problem. Early diagnosis and implementation of treatment is critical if surgery is to be avoided. The results of this pilot study suggest an alternative treatment for open bite patients with promising results. Mastication exercises in conjunction with concentrated vertical control seemed to reduce aberrant vertical growth patterns in the patients.

References

1. Shapiro PA: Stability of open bite treatment. Am J Orthod Dentofacial Orthop 121:566-568, 2002
2. Beckmann SH, Kuitert RB, Prahl-Andersen B: Alveolar and skeletal dimensions associated with overbite. Am J Orthod Dentofacial Orthop 113:443-453, 1998
3. Proffit WR: Contemporary Orthodontics. 3rd ed. Mosby Publishing, St Louis, 2000, p 13
4. Fields H, Proffit WR, Nixon WL, et al: Facial pattern differences in long-faced children and adults. Am J Orthod 85:217-223, 1984
5. Dung DJ, Smith RJ: Cephalometric and clinical diagnosis of open-bite tendency. Am J Orthod Dentofacial Orthop 94:484-490, 1988
6. English JD: Early treatment of skeletal open bite malocclusions. Am J Orthod Dentofacial Orthop 121:563-566, 2002
7. Cangialosi TJ: Skeletal morphologic features of anterior open bite. Am J Orthod 85:28-36, 1984
8. Nahoum H: Anterior open bite: a cephalometric analysis and suggested treatment procedures. Am J Orthod 67:523-531, 1975
9. Fields HW, Proffit WR, Nixon WL, et al: Facial pattern and differences in long face children and adults. Am J Orthod 85:217-223, 1984
10. Beane RA: Nonsurgical management of the anterior open bite: a review of the options. Semin Orthod 5:275-283, 1999
11. Ngan P: Open bite: a review of etiology and management. Pediatr Dent 19:91-98, 1997
12. Profitt WR: Contemporary Orthodontics. 3rd ed. Mosby Publishing, St Louis, 2000, p 136
13. Iscan HN: Effects of vertical chincap therapy on the mandibular morphology in open-bite patients. Am J Orthod Dentofacial Orthop 122: 506-511, 2002
14. Kuster R, Ingervall B: The effect of treatment of skeletal open bite with two types of bite-blocks. Eur J Orthod 14:489-499, 1992
15. Lindsey CA, English JD: Orthodontic treatment and masticatory muscle exercises to correct a Class I open bite in an adult patient. Am J Orthod Dentofacial Orthop 124:91-99, 2003
16. Sherwood KH, Burch JG, Thompson WJ: Closing anterior open bites by intruding molars with titanium miniplate anchorage. J Orthod Dentofacial Orthop 122:593-600, 2002
17. Umemori M, Saguwara J, Mitani H, et al: Skeletal anchorage system for open-bite correction. Am J Orthod Dentofacial Orthop 115:116-174, 1999
18. Sugawara J, Baik UB, Umemori M, et al. Treatment and posttreatment dentoalveolar changes following intrusion of mandibular molars with application of a skeletal anchorage system for open bite correction. Int J Adult Orthodon Orthognath Surg 17:243-253, 2002
19. Opdebeeck H, Bell WH: Short face syndrome. Am J Orthod 73:499-510, 1978
20. English J, Tran M, Buschang P, et al : Muscle exercise effects on the early treatment of skeletal open-bite malocclusions. J Dent Res 81:33, 2002