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Abstract
There are various forms of skeletal Type III abnormalities. The most common occurs when the maxilla is underdeveloped and the mandible grows ahead of it. In severe cases, skeletal Type III abnormalities are considered the most unattractive as well as being one of the most difficult to treat in orthodontics. A simplified approach is presented for using the Frankel III appliance to treat skeletal Type III abnormalities in young children.

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Skeletal Type III abnormalities—A simplified treatment

With the advent of functional appliances and functional regulators, dental practitioners have the ability to reshape and reposition the maxilla and the mandible in a more esthetic and physiologically ideal position. By doing so, dentists can treat patients to a more beautiful face and alleviate many medical problems such as temporomandibular disorders (TMDs), migraine headaches, upper airway obstructions (mouth breathing), otitis media, tinnitus, and vertigo.[1-7]

One of the greatest challenges in orthodontics is in the correction of skeletal Type III abnormalities. Dental schools teach that the most effective way to correct Type III problems is by orthognathic surgery. This treatment usually is accomplished during the patient's later teen years when facial growth has slowed or stopped. This case report will illustrate an earlier, more simplified technique for treating skeletal Type III abnormalities.

In most cases, this technique utilizes only one removable appliance, the Frankel III, which requires minimal adjustments between appointment visits. However, it must be emphasized that this treatment can be done only in children between the ages of 5 and 8. Additionally, swollen tonsils and adenoids must be surgically removed prior to treatment. Although Frankel III treatment for skeletal Type III problems appears to be simple and straightforward, it should not be attempted by any practitioners who have not received adequate training in orthodontics and diagnosis.

Terminology

Dental Class I, Class II division 1, Class II division 2, and Class III describe the various forms of dental malocclusions. Skeletal Type I, Type II, and Type III describe the various forms of skeletal malpositions or disharmonies. Some researchers favor the term *Type* to describe facial-skeletal disharmonies.[8,9]

Etiology

There have been ongoing debates as to whether genetics or environment cause facial problems, including skeletal Type III abnormalities. Many researchers have associated facial and dental problems with upper airway obstruction and mouth breathing.[10-16] The author recommends that every child with enlarged tonsils or adenoids be evaluated for tonsillectomy and/or adenoidectomy prior to treatment for facial and/or dental problems. In addition to the potential benefit of normal development of the face and dentition, studies have shown that children who had surgery improved their cognitive skill and academic performance compared to those children who retained their swollen tonsils and/or adenoids.[17-20]

Before treatment is rendered, accurate soft tissue, dental, skeletal, and TMD diagnosis should be made. Additionally, any negative medical history and myofunctional habits should be noted. Parents must be informed that these negative findings may have an adverse effect on the outcome.

Appliance

Frankel appliances, also known as functional regulators (FR), were developed by Rolf Frankel.[21,22] FR I and FR II are used to treat skeletal Type II problems; FR III is used to treat skeletal Type III problems; FR IV is used to treat

long face patterns and anterior open bites. Frankel appliances are not orthodontic appliances, which mainly correct dental problems. Rather, they are orthopedic appliances, which can be used to correct skeletal problems.[23]

Frankel states that improper function of the orofacial muscles such as the lips, cheeks, and tongue can cause dental and facial abnormalities. As explained previously, an example of abnormal muscle function is mouth breathing, which has been associated with facial and dental abnormalities. FR appliances are used to train or retrain orofacial musculatures to perform their proper function. These muscles will begin to exert pressure to move the teeth into proper alignment and the alveolar bone into its proper shape and position.[24-26]

Frankel appliances have acrylic vestibular shields outside of the dental arches (Fig. 1 and 2) and should not be confused with "functional appliances" such as the Schwartz and bionator, which have acrylics in the lingual and palatal areas. Frankel appliances are functional regulators. Figure 3 shows how the Frankel's vestibular shields negate the inward pressure of the lip and cheek muscles in a mouth breather so that the tongue can begin to counter and produce greater outward pressure. This helps to reestablish the ideal horseshoe-shaped dental arch.

One of the greatest disadvantages cited for Frankel therapy is patient cooperation in wearing the appliance. If the treatment is presented well, children will cooperate fully in most cases. Young children, even 5-year-olds, are sensitive about their appearance and often may be ridiculed by other children. Most children will wear the appliance if they understand how it will improve their facial appearance. Additionally, this is a conservative treatment that can be discontinued at any time, usually with little harm to the patient. Patient risks as well as treatment time and costs are significantly less than those associated with orthognathic surgery. Finally, beginning treatment at a younger age can help avert the psychological and emotional problems that may result from poor self-image during the formative years.

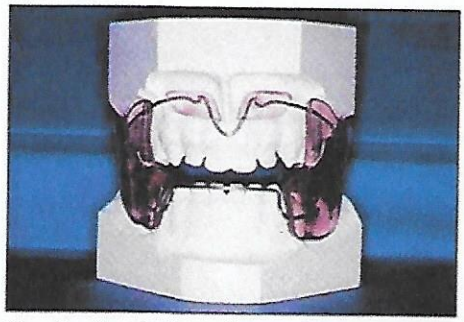

Fig. 1. Frankel III, front view.

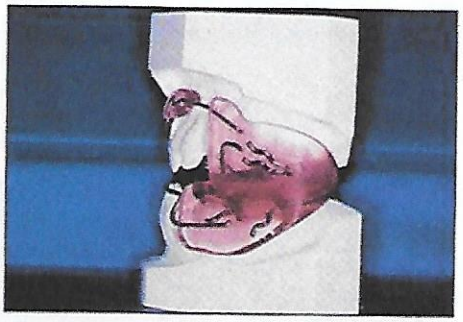

Fig. 2. Frankel III, side view.

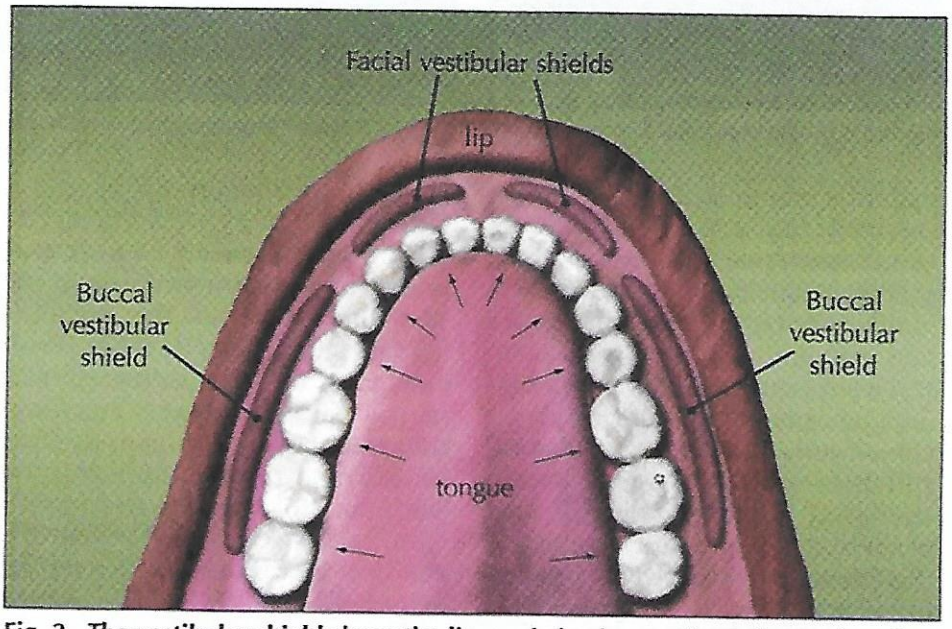

Fig. 3. The vestibular shields keep the lips and cheek away from the teeth and bone, allowing the tongue to exert greater outward pressure.

Patient management

Written informed consent is essential. Never guarantee that treatment will be successful. Parents should be informed that there are other alternative treatments, such as orthognathic surgery. It should be emphasized that if Frankel therapy is successful, it may alleviate the need for surgery. Inform parents that it is possible that the child may need further treatment by an orthodontic specialist when all permanent teeth are fully erupted. As stated previously, parents must be made aware that any negative medical or myofunctional findings may affect treatment results adversely.

Clinical management

Impressions

After accurate diagnosis has been made, maxillary and mandibular alginate impressions are taken for fabrication of the Frankel III appliance. A standard metal stock tray is adequate. However, the tray must be sized correctly to the

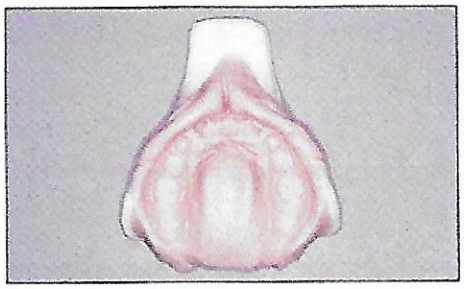

Fig. 4. Maxillary impression.

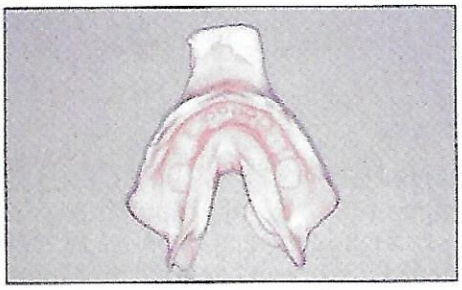

Fig. 5. Mandibular impression.

Fig. 6. Correct wax bite impression.

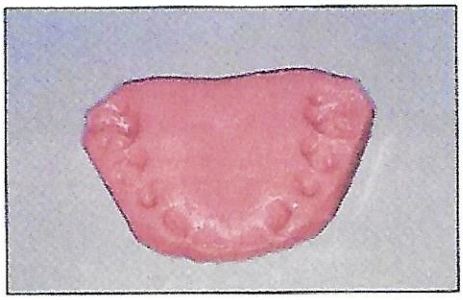

Fig. 7. Wax bite trimmed correctly.

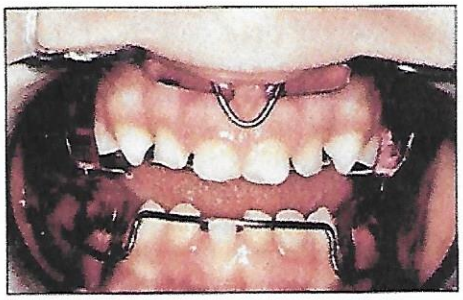

Fig. 8. Frankel III inserted correctly.

patient's mouth so that it is not too small or too large. In addition, bead wax must be placed along the edges of the trays and muscle molded for better vestibular depth and anatomy.

The mixture of alginate should not be runny or too thick; it should have a creamy, bubble-free consistency. Make sure there is enough alginate to flow into the vestibular areas. Add alginate to the vestibular areas with your finger if necessary. Once the tray is seated, muscle mold and gently press the lip and cheek areas to achieve the teardrop-shaped vestibular margins. The margins should not be rounded or knife-edged. Check the impressions for proper reproduction of the teeth, frena, and associated soft tissue.

For some children, metal stock trays may be bulky and uncomfortable. Instead, a disposable foam impression tray by 3M Unitek (Monrovia, CA; 800/634-5300) may be used. Figures 4 and 5 show excellent impressions of the upper and lower arches using this tray. Note that the correct sized trays were used and the vestibular areas of the impression are teardrop-shaped. Bead wax was not placed on the edges of the trays since the vestibular height was adequate.

Wax bite registration

Use good quality preformed bite wafers or two sheets of pink wax folded and cut to conform to the size and shape of the patient's dental arch. Place in a hot water bath until the wax softens. Place in the patient's mouth and have the patient bite down into the wax in normal mandibular closure. The mandible should not be forward or backward of its natural position, nor should it be shifted to either side. Have the patient stop biting when the maxillary and mandibular incisors are approximately 2.0–3.0 mm apart (Fig. 6). If the permanent incisors are not fully erupted, visually estimate their height when fully erupted and have wax 2.0–3.0 mm from the estimated height. Also, make sure that the maxillary and mandibular midline frena are centered. It is more important to center the skeletal midlines than the dental midlines.

Trim the anterior portion of the wax so that the distance of the maxillary and mandibular incisors can be measured. Trim the posterior portions to the buccals of the posterior teeth (Fig. 7). If the wax bite becomes distorted during trimming, run it under cold water and have the patient bite into it to reestablish correct bite registration.

Laboratory prescription

Many laboratories discontinued making the Frankel appliance due to lack of demand. Great Lakes Orthodontics, Ltd. (Tonawanda, NY; 800/828-7626), QC Orthodontics Laboratory (Fuquay Varina, NC; 919/577-2250), Johns Dental Laboratories (Terre Haute, IN; 800/457-0504), and Dyna Flex Lab (St. Louis, MO; 800/489-4020) are a few that still will fabricate the appliance.

Package the maxillary and mandibular model casts and the wax bite registration carefully and send to the laboratory with the following instructions:

> Rx: Please fabricate Frankel III appliance to correct skeletal Type III abnormality and to develop the maxilla forward. If there are any problems with the models or the wax bite, please contact me.

Appliance insertion

Insert the appliance and check for any areas of irritation. Adjust as necessary. Check placement of anterior teeth and make sure that they are positioned correctly (Fig. 8). Note that deciduous tooth P is in facial version of the mandibular labial bow. Normally, this would not be correct; however, because tooth P is ready to exfoliate and the rest of the lower incisors are in

Fig. 9 and 10. Child practicing placing appliance in the mouth.

Fig. 11. Holes cut distal to the wires.

Fig. 12. Wires pushed forward on both sides.

Fig. 13. Hole filled with acrylic.

Fig. 14. Smoothing and polishing the appliance.

correct position on the appliance, the placement of the Frankel appliance in this instance is correct. It is important that the child is able to insert and remove the appliance. Have the child practice doing this in the office until he or she can do so comfortably (Fig. 9 and 10).

Advise parents and patients that the appliance is fragile and care should be taken not to abuse it. If it is inadvertently broken or distorted, a new appliance should be made. Whenever the appliance is not worn, it should be placed in its container. The appliance should never be wrapped in paper towels or tissues and left unattended; too often, appliances wrapped in this manner have been thrown away. Never leave the appliance out for dogs or cats to chew and never leave it out under the hot sun.

The appliance must be worn at all times (including nights) except during eating, brushing, and participation in rough sports. Children should not be eating snacks frequently during the day. The appliance should be cleaned thoroughly several times a day with a toothbrush, especially before going to bed. Emphasize that unless worn as instructed, the treatment will not be successful. Instruct parents to call the office should any problems occur.

Appointments and length of treatment

The patient should be seen two weeks after appliance insertion. At this visit, check for sore spots and adjust if necessary. Also, check to make sure that the anterior teeth still are positioned correctly with the appliance in place. More importantly, determine whether the patient has been compliant. If not, this should be noted in the record. Emphasize again to parents and child that the treatment will fail unless worn as instructed. Thereafter, the patient should be scheduled every two months to check for sore spots and patient cooperation. Again, instruct to call the office if there are any problems.

If the child is wearing the appliance, skeletal and dental improvements should be evident by the second and fourth months. After the fourth month, the maxilla may develop forward and come in contact with the maxillary labial pads. If this occurs, holes distal to the wires holding the maxillary pads should be cut out of the buccal vestibular shields (Fig. 11). With an instrument, push the wires forward on both sides until the labial pads are approximately 2.0 mm away from the maxillary tissue (Fig. 12). Insert the appliance in the child's mouth and make sure that the maxillary pads are centered and that the appliance is comfortable. Fill in the holes with acrylic as shown in Figure 13. Smooth and polish as shown in Figure 14. Continue to see the child every two months.

Length of treatment varies with each child depending on age, cooperation, lifestyle, and physiology. In the author's experience, treatment can take between 4 and 24 months. It is important to note that once treatment is completed, there is no need for retainers, assuming that upper airway obstructions have been corrected.

Case report

A woman sought treatment for her 5-year 11-month old daughter's "underbite." The girl's medical history was not significant. She was bottle-fed as a baby; however, she was not a mouth breather and she did not snore in her sleep. Her tonsils had not been removed.

Diagnosis

The facial photographs (Fig. 15–17) show a concave facial profile.

Fig. 15-17. Pretreatment facial view of patient, aged 5 years, 11 months.

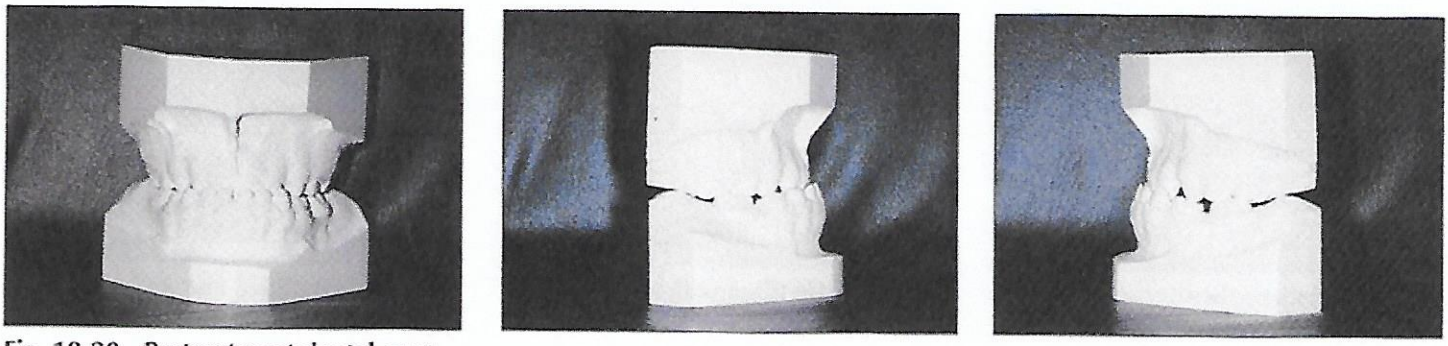

Fig. 18-20. Pretreatment dental casts.

There is significant mandibular prognathism relative to the maxilla. On smiling, only her lower anterior teeth and gingiva are visible. The dental casts (Fig. 18–20) show a dental Class III relationship.

Her panoramic radiograph shows a normal eruption pattern relative to her age. Her pretreatment cephalometric landmarks (Fig. 21) clearly show that her maxilla and mandible are in Type III malposition and her lower facial height is nearly normal. Based on her diagnosis, the treatment objectives are to correct the Class III dental malocclusion and the skeletal Type III malposition and to improve facial and dental esthetics, the facial profile, and function.

Treatment plan

The first treatment option is to do nothing. The second option is to wait until the child is nearly 18 years old and to treat via orthognathic surgery. The third option is to expand the palate and use a forward protraction headgear (reverse face mask) and finish with fixed appliances. The fourth option is to use the Frankel III. Because of the ideal age of the patient and the reduction in cost, risks, and complications, it was decided to treat with the Frankel III with an estimated treatment time of approximately 24 months.

Treatment progress

Orthodontic records were taken on September 3, 1996 and the Frankel III appliance was inserted on October 21. The patient was scheduled for treatment evaluation on November 4, at which time the following notation was made in her chart: "Maxilla moving forward—now touching behind lower teeth whereas before they did not touch." Thereafter, the patient was seen every two months.

Four months later, on February 10, 1997, the record showed correction from Class III to Class I. The patient's dentition was not in ideal occlusion since deciduous teeth were in the process of exfoliating. Therefore, treatment was continued. The patient was seen on May 5 and it was noted that there were significant improvements. However, the child was not wearing the appliance in school. The mother was advised that the child must wear the appliance day and night. The child was seen every two months for nearly two years, at which point the mother opted to discontinue

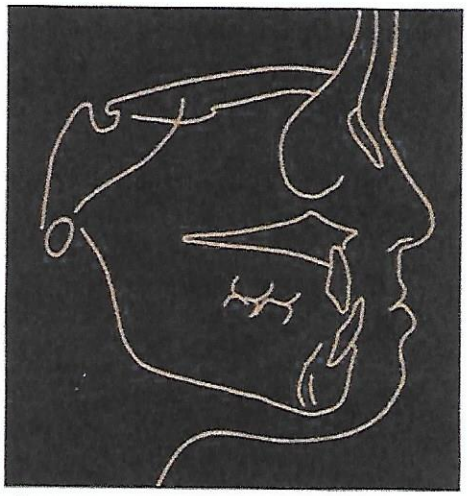

Fig. 21. Pretreatment cephalometric landmarks. Patient aged 5 years, 11 months.

treatment due to the great distance they had to travel to keep the appointments. Treatment was discontinued on April 5, 1999 and no retainers were inserted.

Treatment results

The facial photographs (Fig. 22–24) show significant improvement in facial esthetics and profile. The patient's mandibular prognathism is reduced and her profile is straight and nearly ideal. She has a pleasing and more natural smile. The dental casts (Fig. 25–27) show a slight Class II anterior relationship.



Fig. 22-24. Posttreatment facial view of patient, aged 8 years, 5 months.

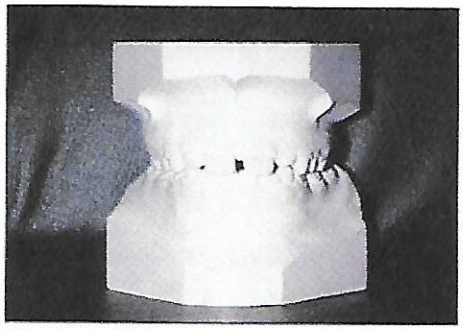
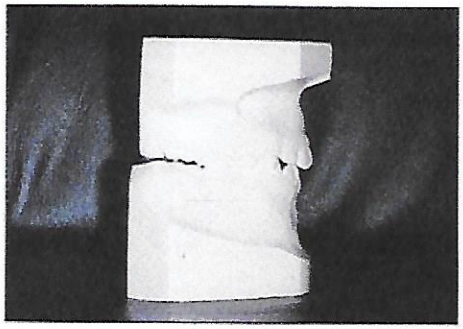
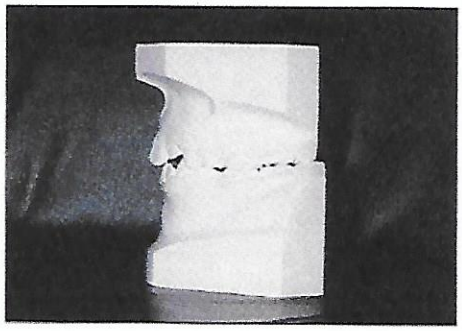

Fig. 25-27. Posttreatment dental casts.

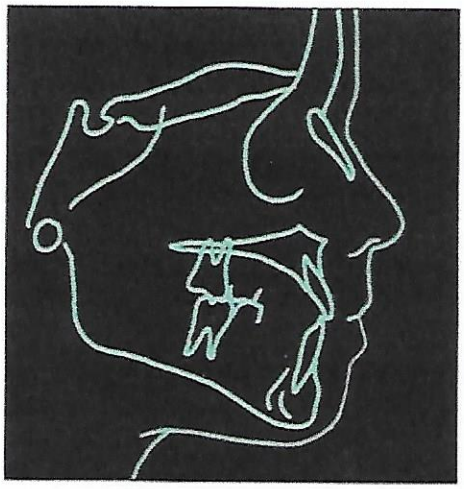

Fig. 28. Posttreatment cephalometric landmarks. Patient aged 8 years, 5 months.

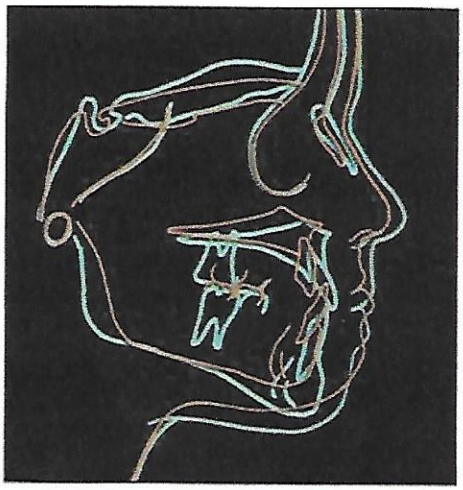

Fig. 29. Superimposition of pretreatment and posttreatment cephalometric tracings. Orange line is pretreatment; blue line is posttreatment.

Because this case was terminated before all permanent teeth were fully erupted, the occlusion was not finalized in the ideal Class I relationship. In all likelihood, her slight Class II dentition will settle into Class I relationship as her permanent teeth fully erupt. Unfortunately, there was no posttreatment follow-up.

The posttreatment panoramic radiograph shows normal eruption pattern relative to her age. Posttreatment cephalometric landmarks (Fig. 28) show that the maxillary and mandibular anteroposterior relationship to the cranial base is nearly ideal, although the mandible still may be slightly prognathic. Her lower facial height is ideal. This correlates to the patient's nearly ideal facial profile.

Superimpositions of the pretreatment and posttreatment cephalometric tracings (Fig. 29) show a vertical pattern of facial growth, some forward maxillary development, and a slight backward development of the mandible. There were some proclinations of the maxillary incisors.

Summary

This case report illustrates the esthetic and functional benefits of the Frankel III appliance in the treatment of skeletal Type III abnormalities. Further, it underscores the need to diagnose and treat this problem at a younger age when this treatment technique is most effective.

Author Information

Dr. Jefferson has a private family dentistry practice in Mount Holly, Jew Jersey.

References

1. Van Sickels JE, Ivey DW. Myofacial pain dysfunction: A manifestation of the short-face syndrome. J Prosthet Dent 1979;42:547-550.

2. Abadi BJ, Okeson JP. Alteration of vertical dimension in the treatment of craniomandibular disorder. Cranio 1982-1983;1:55-59.

3. Fonder AC. The dental physician, ed. 2. Rock Falls, IL; Medical-Dental Arts;1985.

4. Fonder AC. The dental distress syndrome. Rock Falls, IL; Medical-Dental Arts;1990.

5. Marasa FK, Ham BD. Case reports involving the treatment of children with chronic otitis media with effusion via craniomandbiular methods. Cranio 1988;6:256-270.

6. Loudon ME. Recent advancement in vertical dimension: Primary molar buildups. Funct Ortho 1990;7:10-17.

7. Jefferson Y. TMD assessment using the Sassouni analysis. 1. J Gen Orthod 1991;2:11-15.

8. Goldsman S. The variation in skeletal and denture patterns in excellent adult facial types. Angle Orthod 1959;29:63-92.

9. Sassouni V. A classification of skeletal facial types. Am J Orthod 1969;55:109-123.

10. Ricketts RM. Respiratory obstruction syndrome. Am J Orthod 1968;54:495-507.

11. Rubin RM. Mode of respiration and facial growth. Am J Orthod 1980; 78:504-510.

12. Quinn GW. Airway interference and its effect upon the growth and development of the face, jaws, dentition, and associated parts. N C Dent J 1978;61:28-31.

13. Principato JJ, Kerrigan JP, Wolf P. Pediatric nasal resistance and lower anterior vertical face height. Presented at the American Academy of Otolaryngology—Head and Neck Surgery, September 1984.

14. Cheng MC, Enlow DH, Papsidero M, Broadbent BH Jr, Oyen O, Sabat M. Developmental effects of impaired breathing in the face of a growing child. Angle Orthod 1988;58:309-320.

15. Marks MB. Allergy in relation to orofacial deformities in children: A review. J Allergy 1965;36:293-302.

16. Gensior AM. The tongue and Class III. Am J Orthod 1970;57:256-259.

17. Gozal D. Sleep-disordered breathing and school performance in children. Pediatrics 1998;102:616-620.

18. Goldstein NA, Post JC, Rosenfeld RM, Campbell TF. Impact of tonsillectomy and adenoidectomy on child behavior. Arch Otolarygol Head Neck Surg 2000;126:494-498.

19. Brouillette RT, Fernbach SK, Hunt CE. Obstructive sleep apnea in infants and children. J Pediatr 1982;100: 31-40.

20. Greene MG, Carroll JL. Consequences of sleep-disordered breathing in childhood. Curr Opin Pulm Med 1997;3:456-463.

21. Frankel R. The theoretical concept underlying the treatment with functional correctors. Rep Congr Eur Orthod Soc 1966;42:233-254.

22. Frankel R. Maxillary retrusion in Class III and treatment with the functional corrector. Rep Congr Eur Orthod Soc 1970:249-259.

23. Frankel R. A functional approach to orofacial orthopedics. Br J Orthod 1980;7:41-51.

24. Harvold EP. The role of function in the etiology and treament of malocclusion. Am J Orthod 1968;54: 883-898.

25. Paul JL, Nanda RS. Effect of mouth breathing on dental occlusion. Angle Orthod 1973;43:201-206.

26. Ackerman RI, Klapper K. Tongue position and open-bite: The key roles of growth and the nasopharyngeal airway. ASDC J Dent Child 1981;48:339-345.