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Premaxillary Distraction Osteogenesis with an Individual Tooth-Borne Appliance

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ABSTRACT

Distraction osteogenesis defines a technique of bone generation and osteosynthesis by the distraction of native preexisting bone. The technique offers a promising treatment alternative for patients with maxillary hypoplasia and a retrognathic mandible. In this case report, the steps in the treatment of an 18.2-year-old girl with premaxillary hypoplasia and anterior crossbite are described. The patient was treated with a distraction osteogenesis technique, and premaxillary advancement was performed using an individual tooth-borne distraction device. The surgical operation consisted of a classical segmental maxillary osteotomy carefully respecting the palatal periosteum. The distractor was cemented in the mouth after the surgical procedures. The patient was observed during a seven-day latency period, after which the device was activated 0.5 mm every 12 hours. The anterior crossbite was eliminated in one week, and the treatment was finished with fixed orthodontic appliances.

KEY WORDS: Premaxilla, Tooth-borne, Distraction.

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INTRODUCTION Return to TOC

Distraction osteogenesis is the gradual mechanical traction of bone segments at an osteotomy site to generate new bone. Distraction osteogenesis can be classified as monofocal, bifocal, and trifocal osteosynthesis.[1] In 1927, Rosenthal performed the first osteodistraction procedure in the maxillofacial region, and in the following years, Kazanjian and Crawford also presented studies about mandibular osteodistraction. In the late 1950s, Köle was the first to demonstrate a combined orthodontic and surgical technique for rapid expansion of the palate in adults. Distraction osteogenesis did not gain immediate acceptance, however, because of a lack of control over the bony segments and the inadequacy of the distraction devices.[2]

The introduction of distraction protocols for limb lengthening in the 1960s[3] stimulated interest in this technique. Ilizarov[4] reported that the optimum rate of distraction was 1 mm per day. As technology improved over the past 10 years, distraction osteogenesis became increasingly popular in the craniofacial region, and a large number of studies[5–33] have shown that the jaws can be advanced successfully with extraoral or intraoral distraction devices. Mandibular distraction, however, has received more attention than the maxilla.[5–16] In 1993, however, Rachmiel et al[17] achieved maxillary advancement with distraction osteogenesis in adult sheep, and an increasing number of studies[18–33] have shown successful results in the advancement of the maxilla or midface region. Block et al[19,20] observed that dental movement was significantly greater than skeletal movement with tooth-borne distraction devices and mentioned the need for skeletal fixation. On the other hand, Michieli and Miotti[5] and Dolanmaz et al[33] reported satisfactory results with tooth-borne distractors.

A review of the literature shows that studies related to premaxillary advancement are rare. Block et al[19,20] demonstrated anterior maxillary advancement using tooth-borne and implant-supported distraction devices in dogs. Kaluzinski et al[32] achieved premaxillary distraction using individual extra-mucosal devices in three patients and Dolanmaz et al[33] advanced the anterior maxillary alveolar region of a patient with a tooth-borne distractor.

In this report, the premaxillary advancement and orthodontic treatment of an 18.2-year-old girl with a Class III pattern and premaxillary hypoplasia are presented. The premaxillary region of the patient was distracted using an individual tooth-borne device.

CASE REPORT Return to TOC

Diagnosis and etiology

The patient was an 18.2-year-old girl with an anterior crossbite and a linear profile. According to her medical history, her permanent canines erupted in labioversion and were extracted by a practitioner 6.5 years ago. Her parents and siblings did not exhibit Class III characteristics. Her chief concern was her appearance.

Clinical examination

Extraorally, the patient presented a brachyfacial pattern with a symmetrical face and an indistinct subnasal sulcus (Figure 1A). She had a linear profile with a slightly prominent chin and a retruded upper lip (Figure 1B). There was a slight improvement in her profile when she opened her mouth.

Intraorally, the maxillary dental midline was deviated to the left. There was dual bite, and in centric relations, there was edge-to-edge incisor contact with the molars in a Class II relationship with a bilateral posterior open bite. In centric occlusion, depending on the anterior movement of the mandible, a negative overjet and five-mm deep bite was present with a Class I molar relationship. The maxillary canines were not in the mouth, and the maxillary laterals were nearly in contact with the maxillary first premolars (Figure 1C– F).

Radiological findings

In the panoramic and periapical radiographs, skeletal and dentoalveolar structures were normal except for a deviated nasal septum (Figure 2A). A lateral cephalogram was performed in centric occlusion, and the cephalometric analysis indicated a skeletal Class III relationship (Figure 2B,C). This pattern originated from both the premaxillary hypoplasia and excessive mandibular length. The anterior face height was excessive, but the ratio of lower anterior face height to total anterior face height was normal. The maxillary incisors were retrusive, but the mandibular incisors were normally placed over basal bone. The upper lip was retruded to the E line, and the nasolabial angle was decreased (Table 1).

Treatment objectives

The significant problems were a negative anterior overjet, absence of an acceptable profile, and the absent canines. Additionally, because the patient had a dual bite, at the end of the orthodontic treatment, maximum intercuspation would be another problem. When the possible treatment options were discussed with the patient and her parents, they had concerns about acute reconstructive surgical methods.

Thus, the treatment objectives included the following:

- correction of the anterior crossbite
- finishing treatment with an acceptable profile
- creating space for the absent canines
- shortening the treatment period
- increasing the maxillary arch perimeter
- maximum intercuspation
- minimum trauma.

Treatment alternatives

After evaluating the clinical and radiological findings and the radiological and model setups, the potential outcomes were evaluated meticulously before deciding on a treatment plan. The radiological setups included bimaxillary surgery, Le Fort I osteotomy, mandibular setback osteotomy, and premaxillary distraction.

1. A conventional treatment plan for the patient was fixed orthodontic treatment and bimaxillary surgery. A cephalometric setup showed that in this case the maxillary incisor teeth would be intruded with palatal root torque before surgery and the posterior teeth would be in a dental Class II relationship after the surgery, with a need for subsequent orthodontic treatment. There would be a relative expansion in the maxilla and a relative narrowness in the mandibular dental arches after the Le Fort I and mandibular setback osteotomies. Furthermore, it was impossible to increase the maxillary arch perimeter with a Le Fort I osteotomy.

2. A Le Fort I and mandibular setback osteotomies alone were the other alternatives. It was observed from the setups that these methods would include many of the disadvantages of bimaxillary surgery.

3. The other treatment option for the patient was premaxillary distraction osteogenesis because the dual bite of the patient was an advantage in minimizing the surgical procedures. Radiological setups showed no significant difference in the soft tissue profile of the patient when premaxillary distraction was compared with other treatment methods. The intercuspation of the patient would not be changed significantly because the posterior teeth would be nearly intact. When the problems of creating space for the maxillary canines, minimum trauma, and minimum rehabilitation and treatment periods were also considered, monofocal distraction of the premaxilla was selected as the best treatment planned for the patient.

Treated progress

An individual tooth-borne distractor was designed capable of delivering 6.75 mm of anterior movement and 15° of upward movement of the premaxilla. Bilateral implant insertion into edentulous alveolar bone was planned after the orthodontic treatment to prevent a relapse tendency. The treatment procedures were explained to the patient, and she accepted them.

Construction of the distractor

A rigid and retentive cap splint–type device was designed. Separation elastics were placed between several teeth because the appliance was to include molar, premolar, and lateral incisor bands. After 24 hours, the elastics were removed and the appropriate bands for maxillary first molars, maxillary first premolars, and the maxillary left lateral were chosen. Retention bars of 0.7-mm wire were soldered to the buccal surfaces of the premolar and lateral bands. The bands were seated in the mouth, an alginate impression was obtained, and the bands were seated in the impression material. Five extra bands of the same size as their originals were seated on the patient to prevent space closure while the appliance was being constructed.

A Hyrax expansion screw was placed parallel to the midpalatal suture and soldered to the first molar bands while the anterior extension of the screw rested on the cingulum of the anterior teeth. The molar and premolar bands were connected with 0.7-mm wires to reinforce the rigidity and retention of the appliance (Figure 3A). The crowns of the maxillary teeth were coated with self-cured acrylic and polymerized. After polymerization, the splint was trimmed with burs and, using a fine separator, the anterior and posterior parts of the acrylic were separated between the maxillary laterals and first premolars. Then it was polished (Figure 3B).

Surgical method

A maxillary anterior segmental osteotomy was planned, and the surgery was performed under general anesthesia. The space-retaining bands were removed, and a horizontal incision was made between the first premolars five mm above the attached gingiva. A mucoperiosteal flap was dissected superiorly, and vertical osteotomy lines were marked between the incision and apertura priformis using a round bur. The marks were connected with a surgical saw. Interdental, palatal, and nasal surface osteotomies were performed by an interdental osteotome, and with the guidance of the vertical osteotomies, the osteotomy lines were joined with each other, and the anterior segment was freely movable (Figure 4). The wound was closed with 3-;0 silk suture material, and the surgical procedure was finished. After the surgery, the patient was taken to the recovery room and two hours later an individual tooth-borne distractor was cemented in the mouth. The patient was prescribed oral penicillin (Amoxicilline1 × 2 g/d) and a mouth rinse (chlorhexidine gluconate) during the five-day postoperative period.

Distraction protocol

The patient was observed during the seven-day latency period, and then distraction was begun. The screw was advanced 0.5 mm twice a day (1 mm) for six days, and on the seventh day the device was activated 0.75 mm. The consolidation period was eight weeks, and the tooth-borne distractor was removed. The occlusal photograph of the distractor at the end of latency period is shown in Figure 5.

Treatment results

At the end of the distraction period, the anterior crossbite of the patient was eliminated (Figure 6). Cephalometric radiographs and tracings were repeated at the end of the distraction (Figure 7A,B) and consolidation periods. The maxillary parameters were evaluated at the end of the distraction, and it was observed that the SNA angle and NV-A distance were increased by 4° and 6 mm, respectively, whereas the SN/ANS-PNS angle decreased by one mm. The Co-A distance was increased by five mm, and the N- ANS distance was decreased by one mm.

The distance between the anterior and posterior nasal spines was increased by five mm, and the maxillary central showed 8°of labial tipping. The 1-NA distance was increased by three mm, and the 1/NA angle was increased by 4°. In addition, the nasolabial angle increased by 10°.

The measurements at the end of the consolidation period showed that the SNB angle decreased by 1°, whereas ANB increased by 5°. An anterior rotation of 3° was observed in the occlusal plane angle. The ANS-PNS/Go-Gn angle and the ANS-Me distance increased by 3° and two mm, respectively. The interincisal angle decreased by 12°, whereas the overjet increased by six mm, the overbite decreased by three mm, and the upper lip protruded three mm (Table 1). The cephalometric tracings superimposed on the S-N line at the sella illustrate the treatment changes in the patient (Figure 7C).

Orthodontic treatment

Upon removal of the distractor, an 0.016-inch Ni-Ti archwire was used for leveling. This was followed by use of 0.016 × 0.016-inch and 0.016 × 0.022-inch archwires. Finally, the treatment was finished with 0.016 × 0.022- and 0.017 × 0.025-inch blue elgiloy archwires, respectively (Figure 8). After six months, the cephalometric evaluation was repeated (Figure 9), and a Hawley retainer was prepared for the patient after debonding. She was pleased with the improvement of her facial appearance (Figure 10), and her orthodontic models demonstrated the improvement of her dental relationship (Figure 11). Dental implants (Sulzer, Calcitek, San Diego, Calif.) were inserted bilaterally into the distraction areas (Figure 12A–C), and six months after the implant insertion, implant-supported crowns were seated in the canine region (Figure 12D).

DISCUSSION Return to TOC

In recent years, distraction osteogenesis techniques have become increasingly popular in orthodontics and oral and maxillofacial surgery, and studies related to the maxilla are more frequently observed in the literature.[17–33] Block et al,[19,20] using tooth-borne and implant-supported devices, demonstrated anterior maxillary advancement in dogs and compared the skeletal and dental relapse. They observed less dental relapse with implant-supported distractors. However, Altuna et al[21,22] used a tooth-borne device on primates and observed that maxillary advancement with tooth-borne distractors is reliable. Michieli and Miotti[5] and Dolanmaz et al[33] also reported successful results using tooth-borne devices in distraction osteogenesis.

Kaluzinski et al[32] advanced the premaxilla of three patients using intraoral bone-supported devices and reported functional and esthetic results. They also mentioned that distraction osteogenesis techniques have had a low morbidity rate in the grafts of flaps when compared with bone implants. Dolanmaz et al[33] used a tooth-borne device similar to that of Altuna et al[21] for maxillary segmental anterior advancement of a 42-year-old man with a Class III pattern when preparing the patient for prosthetic reconstruction. They reported eight mm of movement of the anterior segment and demonstrated acceptable treatment results. The literature review shows that this was the only clinical application similar to our study, but it differs from our study in some aspects and these have to be addressed.

One of the differences was the extent of the osteotomy line. In our case, the osteotomy border included the apertura priformis bilaterally, and the spina nasalis anterior (SPA) also moved forward with the anterior segment. Because 15° of upward movement was planned, the movement of anterior segment not only improved the upper lip but also affected the tip of the nose, improving the nasal profile. Perhaps Dolanmaz et al[33] used palatal coverage in the distractor because they did not have enough teeth for retention. In our opinion, however, if the duration of the distraction + consolidation period and hygienic properties of the distractor are taken into consideration, palatal coverage must be avoided if possible when using tooth-borne devices for anterior maxillary advancement.

The treatment was performed with minimal trauma when compared with other surgical alternative treatment methods. Complications were not observed during and after the distraction period and gingival injuries were not observed at the level of the free marginal gingiva. However, we observed white areas in the attached gingiva at the osteotomy sites just after the activation owing to hemostasis, but the blood supply was improved in a couple of hours. This was related to the distraction rate performed and indicated that the rate of the premaxillary distraction might be less than one mm per day.

Besides avoiding the complications of acute reconstructive surgical methods, distraction of the premaxilla shortened the treatment time because a reduced need for comprehensive orthodontic treatment. In addition, distraction created edentulous spaces in the maxillary arch for implant insertion and improved the facial profile. It is clear that in premaxillary hypoplasia cases SPA and point A are also retrusive, and this must be considered when planning the surgery. It seems logical that the advancement of SPA and point A in such cases will improve the profile and prevent the undesirable tipping of the incisors; however, when the distraction rate is considered, it is clear that further research is needed in this field.

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TABLES Return to TOC

TABLE 1. Cephalometric Evaluation of the Patient

Measurement	Before Treatment	End of Distraction	End of Consolidation	End of Orthodontic Treatment
SNA (°)	80	84	84	84
SNB (°)	82	—	81	81
ANB (°)	−2	—	3	3
NV-A (mm)	−3	3	3	3
NV-Pog (mm)	−2	—	−2	−2
Cranial base (mm)	67	67	67	67
Corpus length (mm)	75	75	75	75
N S Ar (°)	128	128	128	128
S Ar Go (°)	140	—	141	141
Gonial angle (°)	131	131	131	131
Y axis (°)	60	—	59	59
SN/ANS-PNS (°)	8	7	7	7
SN/Occ. plane (°)	23	—	20	20
SN/Go-Gn (°)	39	—	39	39
ANS-PNS/Go-Gn (°)	31	—	34	33
Co-A (mm)	90	95	94	94
Co-Pog (mm)	122	122	123	123
N-Me (mm)	123	—	123	123
N-ANS (mm)	55	54	54	54
ANS-Me (mm)	72	—	74	73
N-ANS/ANS-Me (%)	55.3/67.6	—	55.3/67.6	55.3/67.6
S-Go (mm)	75	—	75	75
S-Go/N-Me (%)	61	—	61	61
ANS-PNS (mm)	51	56	56	56
1/SN (°)	90	98	99	101
1/Go-Gn (°)	78	78	78	78
1/1 (°)	153	—	141	140
1-NA (mm)	0	3	3	4
1/NA (°)	12	16	16	17
1-NB (mm)	3	—	3	3
1/NB (°)	23	—	23	23
E line-upper lip (mm)	−7	—	−4	−4
E line-lower lip (mm)	0	—	0	0
Nasolabial angle (°)	84	94	94	94
Overjet (mm)	−4	—	2	2
Overbite (mm)	5	—	2	2

FIGURES Return to TOC

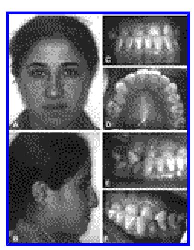

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FIGURE 1. Facial (A, B) and intraoral (C–F) photographs of the patient before treatment

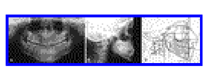

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FIGURE 2. Panaromic (A) and cephalometric (B) radiographs and cephalometric tracing (C) of the patient before treatment

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FIGURE 3. The view of the distractor before (A) and after (B) cap splint

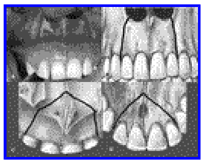

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FIGURE 4. The intraoperative (A) and schematic (B–D) views of the osteotomy line

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FIGURE 5. Occlusal view of the distractor before activation

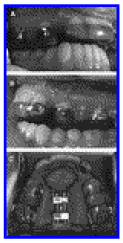

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FIGURE 6. Intraoral photographs of the patient after distraction

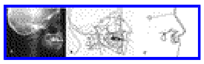

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FIGURE 7. Cephalometric radiograph (A), tracing (B), and superimposition (C) of the patient after the distraction period

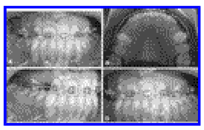

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FIGURE 8. Intraoral photographs of the patient at the end of the orthodontic treatment.

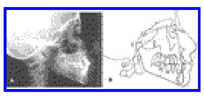

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FIGURE 9. Cephalometric radiograph (A) and tracing (B) of the patient at the end of the orthodontic treatment.

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FIGURE 10. Extraoral and intraoral photographs of the patient at the end of the orthodontic treatment.

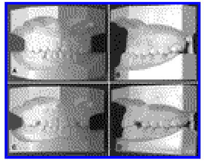

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FIGURE 11. Orthodontic models of the patient before (A, B) and after (C, D) the orthodontic treatment

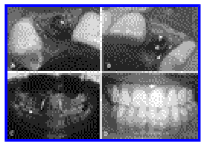

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FIGURE 12. Intraoperative and panoramic views of the dental implants (A–C) and the view of implant-supported crowns (D) at the end of the treatment

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