Case Report

Class II subdivision with skeletal transverse maxillary deficit treated by single-sitting bone-borne appliance: *A case report*

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ABSTRACT
This case report describes orthodontic treatment including both skeletal maxillary expansion and unilateral distalization by means of a single bone-borne appliance followed by clear aligner therapy in a young adult patient. A surgical guide was digitally designed and three-dimensionally printed to facilitate the placement of four miniscrews in the palatal vault. The miniscrews were fitted and the bone-borne appliance was delivered in a single clinical appointment. The postexpansion photographic records and models demonstrate the opening of the palatal median suture, the pure skeletal expansion, and the resolution of the left crossbite after 40 activations. Specifically, left molar Class I was obtained in about 5 months without any loss of anterior anchorage, and the subsequent aligner phase achieved all of the objectives established in the treatment plan. This case report shows clearly how careful digital planning of miniscrew insertion and the delivery of a pure bone-borne appliance in a single sitting enabled good clinical outcomes to be achieved in an acceptable timeframe, without side effects, even in a young adult patient. (*Angle Orthod.* 2021;91:129–137.)

KEY WORDS: Class II subdivision; Aligners; Miniscrew; Rapid palatal expander; Distalizing intraoral appliance

INTRODUCTION

Class II subdivision is a complex malocclusion characterized by a Class II relationship on one side and a Class I relationship on the other. It could represent a challenging clinical issue in terms of treatment planning. Indeed, a recent retrospective study[1] showed that approximately 30% of treated patients had unsatisfactory outcomes, highlighting a certain difficulty in correcting the midline discrepancy.

One of the nonextraction therapeutic approaches most indicated in Class II subdivision is unilateral distalization. This can be performed using an extraoral headgear appliance, which prevents the loss of anterior anchorage but requires a high degree of compliance.[2] On the other hand, tooth-borne intraoral distalizing devices require a lower level of compliance,[3] but the risk of losing anterior anchorage is high.[4]

A very common condition associated with skeletal Class II malocclusion is transverse skeletal deficiency of the maxilla.[5] In younger adult cases, a surgically assisted rapid maxillary expansion is advocated,[6] but despite its efficiency, it is associated with hospitalization and high costs. In order to overcome these side effects, some authors advocate the use of miniscrews to support rapid maxillary expansion in order to transmit orthopedic forces directly to the basal bone, reducing or eliminating periodontal side effects.

Currently, purely bone-borne devices relying on bicortical miniscrew anchorage are available,[7,8] and they are indicated for both pure skeletal expansion and noncompliant intraoral molar distalization.[9] As a matter

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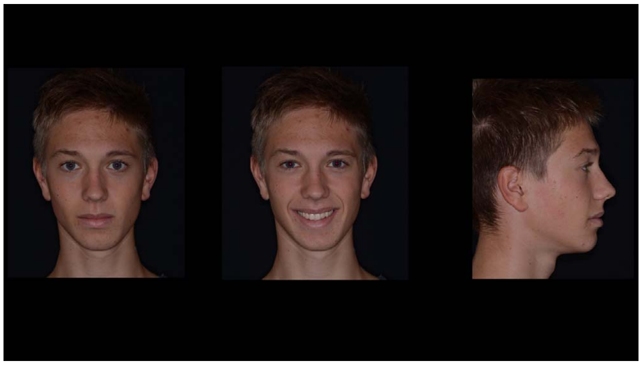

Figure 1. Pretreatment extraoral photographs.

Figure 2. Pretreatment intraoral photographs.

of fact, compliance is never optimal,[10] and molar distalization relying on skeletal anchorage provided by miniscrews inserted in the palatal vault is a noncompliant orthodontic procedure that is now considered safe and reliable.[11] Therefore, adult cases with maxillary transverse deficiency and Class II malocclusion could be treated successfully using miniscrew anchorage in the palatal vault, which is particularly suitable for safe insertion of miniscrews of appropriate length, and also ensuring bicortical anchorage.

Case Report

The purpose of this case report is to illustrate the treatment of a young adult with Class II subdivision and maxillary transverse skeletal deficiency via a single bone-borne appliance fixed onto four miniscrews positioned in the palate with a CAD/CAM surgical guide. Following skeletal expansion and unilateral distalization, aligners were delivered to the patient to refine the occlusion.

Diagnosis and Etiology

A 16-year-old male patient presented with a complaint regarding his "asymmetrical" smile. This was particularly evident at smiling, together with very slight crowding visible in both arches. Extraoral examination revealed an oval-shaped face with a slight skeletal mandibular asymmetry toward the left due to a functional shift. Vertical analysis showed a well-proportioned face, lip competence, and optimal exposure of the upper incisors during smile as well as a smile arc consonant with the lower lip. The facial profile was slightly convex, and the nasolabial angle was obtuse (Figure 1).

Intraoral analysis revealed Class I molar and canine relationships on the right and full Class II molar and canine relationships on the left. While the ratio between overjet and overbite was good, the upper midline was deviated 1 mm toward the right with respect to the facial midline, and the lower midline was deviated 1.5 mm to the left of the facial midline (Figure 2).

The maxillary arch showed reduced transverse dimensions, and there was a molar crossbite on the left side. Specifically, analysis of the maxillary arch revealed bilateral skeletal constriction of the maxilla combined with a buccal coronal inclination of the left mandibular molars. In addition, there was asymmetry in the sagittal direction, with mesial positioning of tooth 26. On the right side, there was a compensating lingual inclination of the lower molars and no crossbite. Together these features pointed to Class II subdivision 2 (Figure 3).

The patient's panoramic radiograph showed the presence of all teeth, with the third molars at the bud stage (Figure 4). Cephalometric analysis revealed a biretrusive Class I intermaxillary relationship (ANB = 1.2°; Wits = –0.4 mm). The vertical facial pattern was normodivergent (FM = 27.3°; SN ^ MP = 35.3°) (Figure 5). The inclinations of both the maxillary and mandibular incisors were normal (Table 1).

Treatment Objectives

The primary objectives of treatment were both to expand skeletally the maxillary arch and restore dentoalveolar symmetry by distalizing the upper left

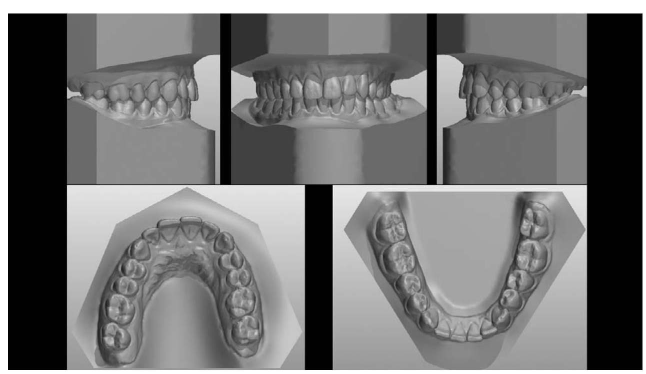

Figure 3. Pretreatment digital models.

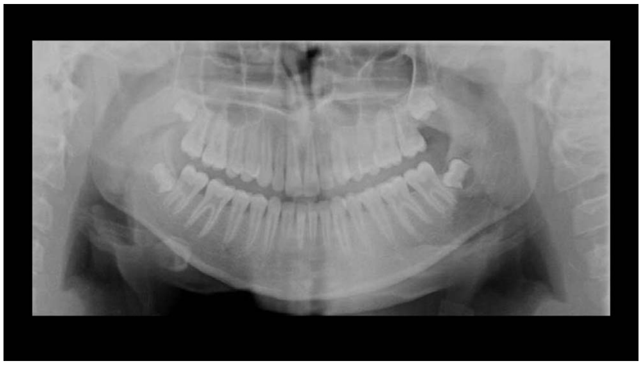

Figure 4. Pretreatment panoramic radiograph.

quadrant, with mesialization of the third quadrant, allowing coordination of both the upper and lower midlines with the facial midline and achieving canine and molar Class I on the left side. Further objectives were to resolve the misalignment and achieve excellent coordination of both arches.

Treatment Alternatives

There were three treatment options considered. The first was a surgical-orthodontic option after growth cessation. This would feature a presurgical orthodontic phase, with the aim of coordinating the dental arches, followed by a surgical phase designed to obtain maxillary skeletal expansion, resolve the mandibular skeletal deviation, and improve the profile through surgical maxillomandibular advancement. However, surgical options were rejected by the young patient and his parents, who refused to consider hospitalization.

The second treatment option proposed was extraction. Considering the presence and the good radiographic shape of the upper left third molar, the unilateral extraction of tooth 24 would be performed in order to center the upper interdental line with the facial midline, achieve a Class I canine relationship on the left, and, at the same time, consolidate the Class II

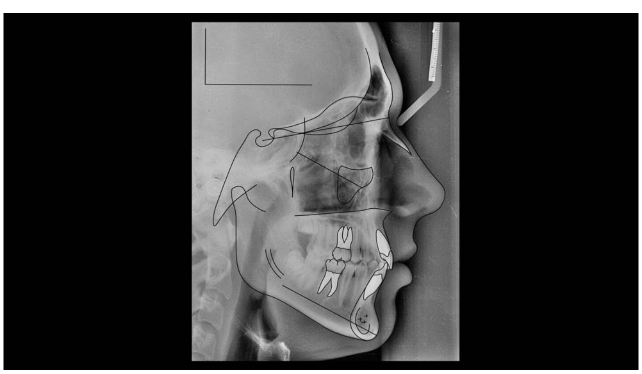

Figure 5. Pretreatment lateral head film and tracing.

Table 1. Pretreatment and Posttreatment Cephalometric Measurements; in the Third Column There Are Normal Cephalometric Values

Measurements	Pretreament	Posttreatment	Norm
Horizontal skeletal			
SNA, °	77.0	76.2	82.0
SNB, °	75.7	74.8	80.0
ANB, °	1.2	1.3	2.0
Maxillary skeletal (A-Na Perp), mm	−4.9	−5.8	0.0
Mandibular skeletal (Pg-Na Perp), mm	−9.7	−11.5	−4.0
Wits appraisal, mm	−0.4	−0.3	0.0
Vertical skeletal			
FMA (MP-FH), °	27.3	27.5	26.0
MP-SN, °	35.3	35.4	33.0
Palatal-mandibular plane, °	27.7	27.1	28.0
Palatal-occlusal plane, °	8.8	8.9	10.0
Mandibular plane to occlusal plane (PP-OP), °	18.9	18.2	18.6
Anterior dental			
U-incisor protrusion (U1-Apo), mm	5.5	3.7	6.0
L1 protrusion (L1-Apo), mm	2.9	1.6	2.0
U1-palatal plane, °	106.8	96.4	110
U1-occlusal plane, °	64.4	74.7	59.0
L1-occlusal plane, °	64.9	71.2	72.0
IMPA, °	96.3	90.6	95.0

molar relationship on the same side. After maxillary expansion, this treatment option would involve a fixed buccal and/or lingual appliance, as these were the only options available to guarantee predictable extraction space closure with root parallelism. However, the patient was informed that this kind of treatment could worsen the profile through upper lip retraction, and, therefore, he expressed his preference for a nonextraction orthodontic intervention that would be both esthetic and comfortable.

In the end, the last option proposed was the one accepted by the patient and his parents after a brief informative consultation. In the first phase of treatment, a single bone-borne device would be fitted, with the intent of achieving both maxillary orthopedic expansion and distalization of the second quadrant. After this first phase, the second phase of occlusal refinement would be performed by clinical aligner therapy (CAT) in order to respect the patient's esthetic demands.

Treatment Progress

During miniscrew insertion, position and depth are of paramount importance in providing secure and bicortical anchorage. This can be assured by the construction of a CAD/CAM surgical guide, after accurate matching of the patient's digital models, preferably via cone-beam computed tomography (CBCT).[7,8] Although modern CBCT is remarkably accurate, the "as low as reasonably achievable" principle should be always

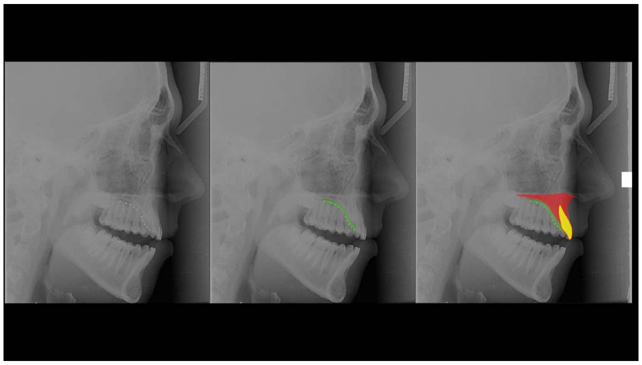

Figure 6. Radiographic lateral head film of patient fitted with a thermoplastic PETG bite registration, with radiopaque markers positioned along the palatine raphe; identification of the profile of palatal mucosa and of the maxillary bone.

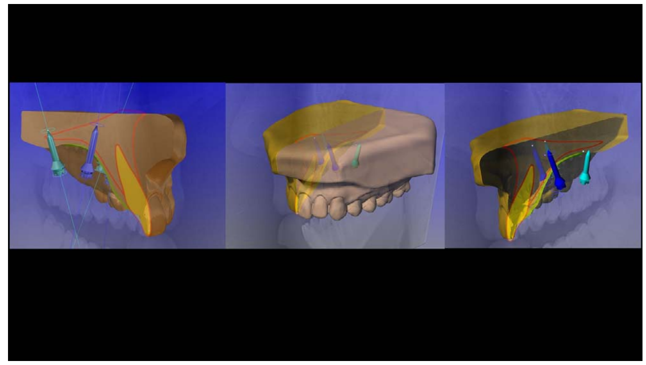

Figure 8. Planning of miniscrew insertion on lateral head film and digital model matching in different views.

respected.[12] According to a study by Kim et al.,[13] the accuracy of a lateral head film in determining the thickness of the palate in the area within 5 mm of the median sagittal plane is comparable with that of CBCT.

Hence, in this case, CBCT exam was replaced by lateral head film acquisition, with the patient's mouth open and a maxillary thermoplastic glycol-modified polyethylene terephthalate (PETG) appliance containing some radiopaque markers positioned along the palatine raphe kept in place (Figure 6). After matching (Figure 7), the optimum direction, position, and length of the miniscrews were evaluated (Figure 8). Four self-drilling Spider Screw Regular Plus miniscrews of 2-mm diameter (HDC, Thiene, Vicenza, Italy) were selected, two of 11-mm length in front and two of 9-mm length further back in the palate (Figure 9). These screws were digitally incorporated into a virtual model of the patient's upper jaw, and a Miniscrew Assisted Palatal Appliance (MAPA) surgical guide was designed (Figure 10). As part of the guide, two cylindrical sheaths were designed to replicate the insertion axis and depth of the miniscrews (Figure 11).

Subsequently, the bone-borne device was constructed (Figure 12). The device featured an acrylic button (1.5–2 mm thick) around an 11-mm expansion screw (Leone Rapid Micro Expander Screw, Leone, Florence, Italy) positioned posteriorly. In the anterior part of the device, two metal abutments with a diameter of 4 mm and congruent with miniscrew heads were joined to the acrylic button, while posteriorly, two holes were created to accommodate the two metal utility abutments during intraoperative assembly of the device. A 0.032-inch titanium-molybdenum alloy (TMA) spring was modelled with a mesially positioned loop to be inserted at the level of the lingual tubes on the molar band on tooth 26 (Figure 13).

The miniscrews were positioned and the device was fitted in a single visit (Figure 14). An expansion protocol with a total of 40 activations (two turns per day) was prescribed, until the median suture opened and the crossbite was corrected (Figure 15). While the post-expansion stabilization phase was occurring, 45° of distal activation was applied to the TMA spring until a super Class I molar relationship was achieved on the left side, with 5 months of repeated activations (Figure 16).

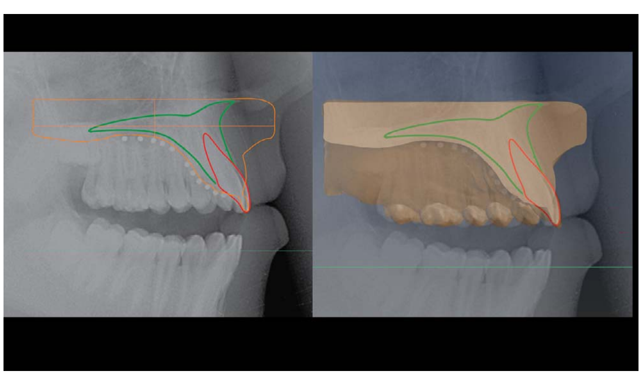

Figure 7. Accurate matching between lateral head film and digital models.

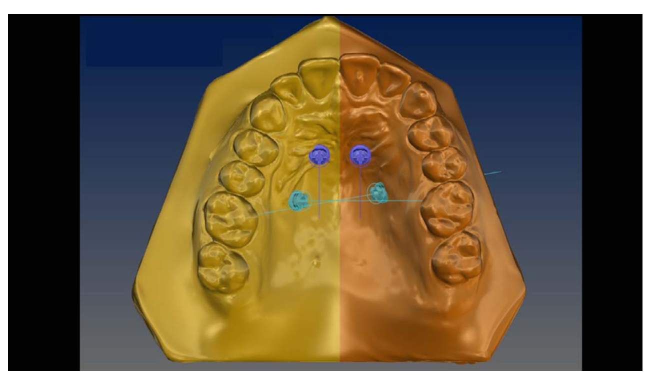

Figure 9. Three-dimensional (3D) digital model of the upper arch with the miniscrews inserted.

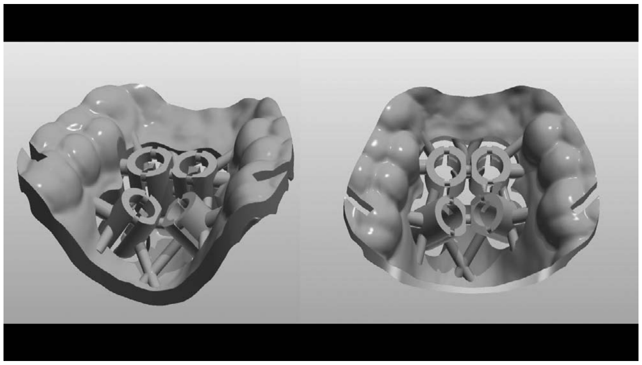

Figure 10. 3D planning and design of MAPA surgical guide.

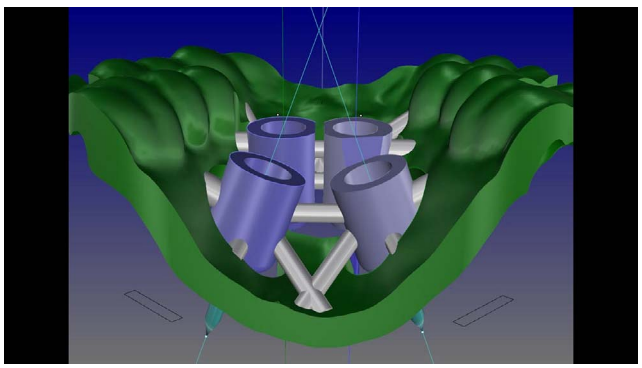

Figure 11. MAPA from the rear view. It is possible to appreciate main body of MAPA (greencolored) cylindrical sheaths (blue colored) and resin bridges (white colored).

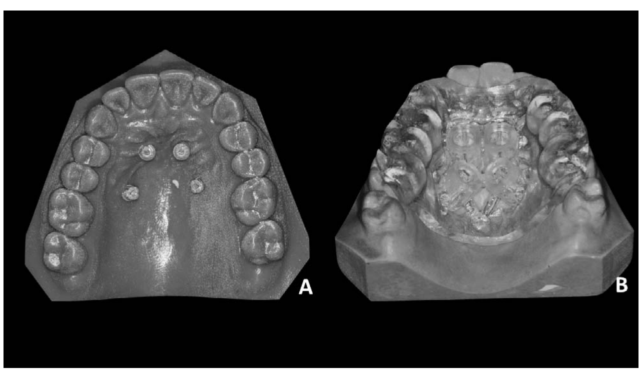

Figure 12. 3D-printed maxillary digital model with miniscrews inserted (A) and 3D printed MAPA surgical guide fitted on model (B).

At this point, new digital models were obtained, and a set-up was designed for the second phase of therapy using F22 aligners (Sweden & Martina, Due Carrare, Padua, Italy). The aligner phase involved 14 steps, with buccal attachments positioned on teeth 16, 14, 24, 25, 34, 35, 44, and 45. The attachments on teeth 11, 21, 22, 23, and 16 were placed lingually in order to improve the esthetic outcome and to encourage root control of the maxillary front teeth. Each pair of aligners was worn for 10 days before moving on to the next

Figure 13. Construction of bone-borne orthodontic appliance with 11-mm expander screw embedded in the acrylic button and 0.032-inch TMA distalizing spring.

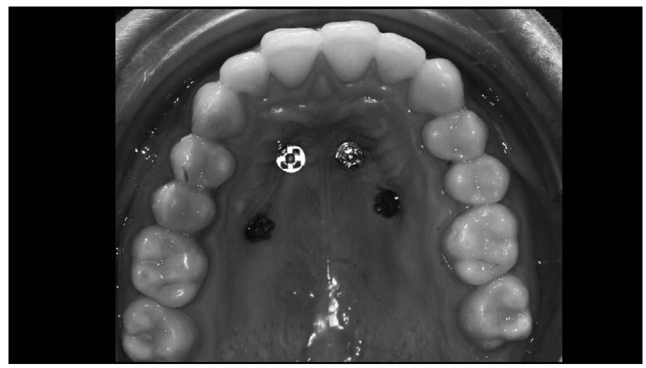

Figure 14. Miniscrews in the palatal vault after insertion and MAPA surgical guide removal.

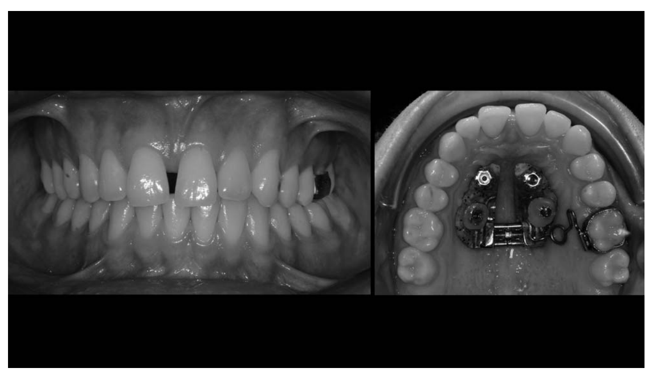

Figure 15. Frontal and occlusal views after active expansion phase with mid–palatal suture opening.

step, and 0.2 mm of interproximal reduction was performed between teeth 11 and 21 and 0.3 mm from the distal side of tooth 35 to the distal side of tooth 45.

In order to encourage distal orthodontic drift, tooth 25 was excluded from the aligner (Figure 17), accepting the risk of its slight extrusion, and after a month of CAT (coinciding with aligner step 4), a 6-ounch, 3/16-inch Class II elastic (Impala, Ormco, Orange, Calif) was applied to the left side. The use of unilateral intermax-

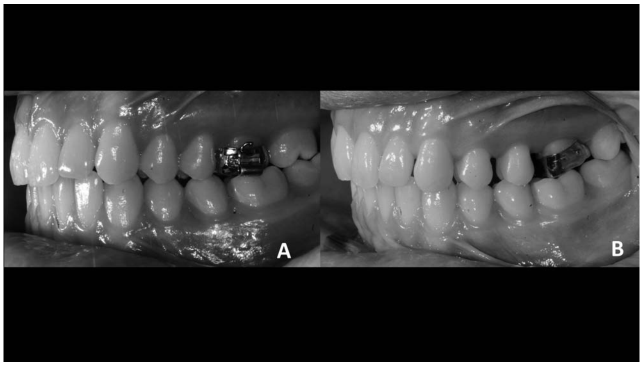

Figure 16. Lateral view of occlusion pretreatment (A) and at the end of distal movement of Tooth 26, when a super Class I relationship had been achieved (B).

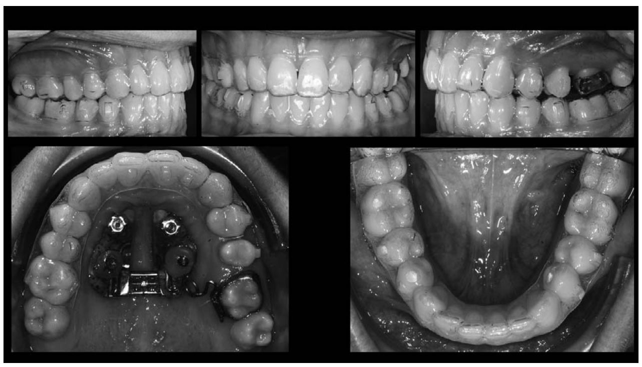

Figure 17. Delivery of aligners to the patient. Tooth 25 is not included in the upper aligner.

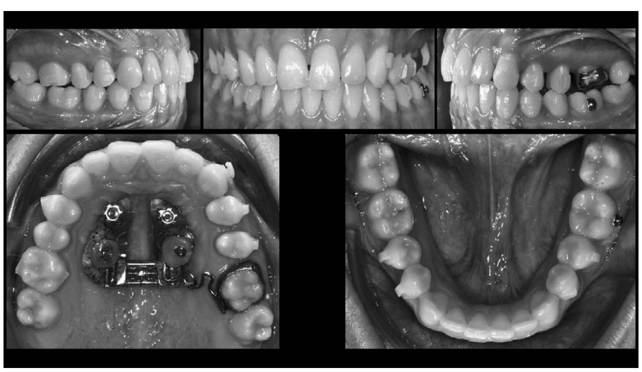

Figure 18. Intraoral photos after four-aligner series. On the left side, a super Class I molar relationship is achieved.

illary Class II elastics, rather than an elastomeric chain stretched between teeth 23 and 26, which would have absolute indirect anchorage, was preferred because one of the main objectives was to obtain a slight mesialization of the lower left quadrant in order to facilitate the centering of the lower midline. The aligners were trimmed in order to accommodate these buttons, and the TMA spring mesial loop on the bone-borne device was opened in order to obtain root control and uprighting of tooth 26 (Figure 18). After 3.5 months

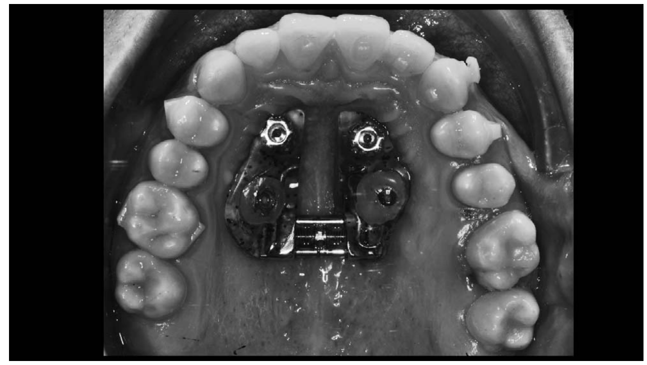

Figure 19. Occlusal view with 0.032-inch TMA spring removal.

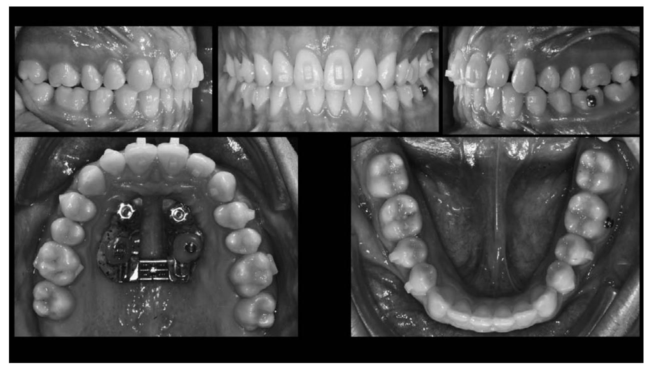

Figure 20. Delivery of second phase of aligners.

of repeated TMA spring mesial loop opening, the TMA spring was removed (Figure 19) and CAT therapy was continued.

One month later, the first phase of CAT had been completed with coordinated midlines. This outcome could be explained by both the functional nature of the mandibular deviation, which disappeared once the left molar crossbite had been resolved, and the Class I relationship established as well as by the subsequent aligner therapy.

After this phase, a further finishing phase of aligners was planned. This had the aim of improving the mechanics of upper midline centering while maintaining good root control (Figure 20); it consisted of seven aligners per arch and additional buccal attachments (rectangular, vertical) at teeth 12, 11, and 21 in order to improve their root positioning. The finishing phase was completed in 2.5 months, resulting in a total treatment time of about 13 months.

Treatment Results

Extraoral analysis showed the coincidence of the dental midlines with the facial midline and good incisor exposure during smile (Figure 21). Regarding the occlusion, bilateral molar and canine Class I with ideal overjet and overbite (2 mm) was achieved. The dental

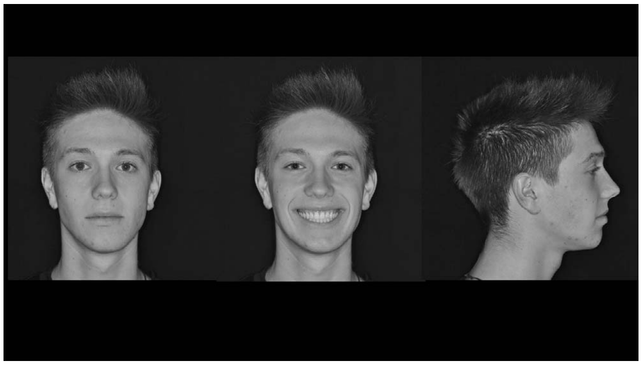

Figure 21. Posttreatment extraoral photographs.

Figure 22. Posttreatment intraoral photographs.

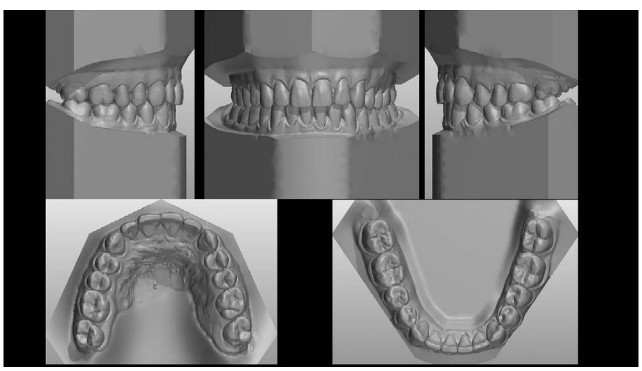

Figure 23. Posttreatment digital models.

Figure 24. Posttreatment panoramic radiograph.

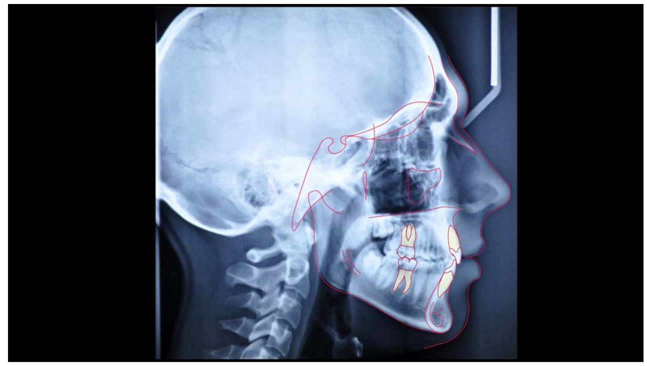

Figure 25. Posttreatment lateral head film.

midlines were centered, and the misalignment resolved in both arches (Figures 21 through 23). The panoramic radiography showed good root parallelism, with no signs of root resorption. Specifically, control of the distalized tooth roots appeared to be excellent (Figure 24).

Posttreatment cephalometric analysis highlighted only dental effects, with retroclination of the upper and lower incisors (Table 1; Figures 25 and 26) and a slight opening rotation of the mandible. Maxillary superimposition clearly showed the translational distal movement of the upper left first molar and the retroclination of the upper incisors (Figure 27).

The pure skeletal maxillary expansion pattern appeared almost parallel, and the intermolar and interpremolar distances increased 3.86 mm and 3.43 mm, respectively (Figure 28). Both the skeletal expansion and unilateral distalization are summarized by the grid comparison between pretreatment and postexpansion and distalization maxillary digital models (Figure 29).

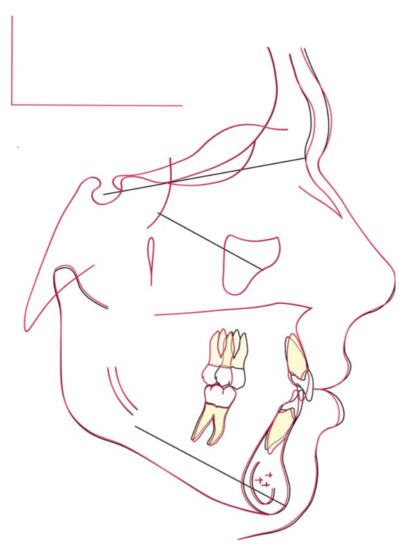

Figure 26. Superimposed tracings.

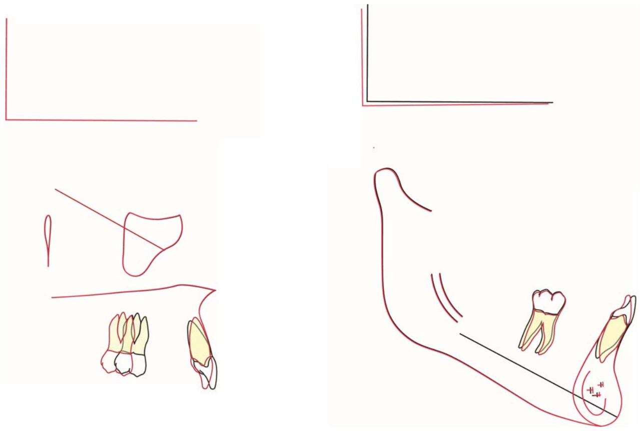

Figure 27. Maxillary and mandibular superimpositions.

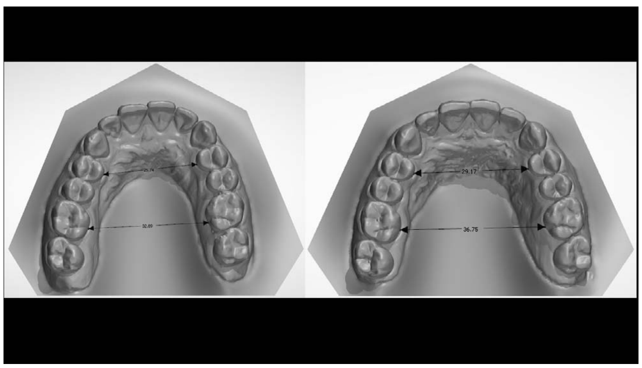

Figure 28. Transverse maxillary measurements of pretreatment and posttreatment digital models.

Figure 29. Grid comparison between pretreatment and postexpansion and post–unilateral distalization digital models.

Figure 30. Post–2-year retention extraoral photographs.

Figure 31. Post–2-year retention intraoral photographs.

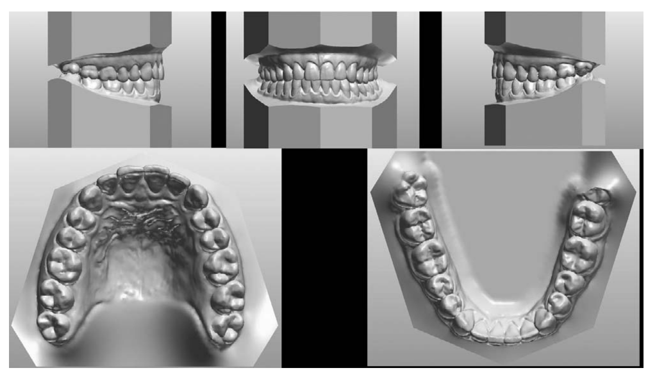

Figure 32. Post–2-year retention digital models.

The 2-year post retention records showed good stability (Figure 30). The retention protocol was 22-h/d use of removable thermoplastic retainers for both arches for the first 6 months after the end of the therapy, which then transitioned to nightly retainer use. Intraorally, spontaneous closure of the space between teeth 22 and 23 occurred. However, slight relapse of the upper and lower dental midlines and the left molar relationship was detectable (Figure 31). Nevertheless, maintenance of tooth alignment was acceptable in both arches following the eruption of third molars (Figure 32).

DISCUSSION

The clinical use of miniscrews has widened the range of treatment options available to clinicians. In fact, their use, especially for orthopedic purposes, has reduced both the indications for surgery in young adult patients and the collateral periodontal effects associated with tooth-borne expansion devices.[7,8]

Eliminating the need for compliance in Class II cases treated with molar distalization with skeletal anchorage has made treatment more predictable, eliminating several of the unwanted effects of dental anchorage, including anterior anchorage loss, and the strong possibility of relapse of the molar distalization during subsequent space closure.[4] The use of the palatal vault as a site for miniscrew placement in cases of transverse maxillary deficit and Class II malocclusion to be treated by means of molar distalization is now considered safe and reliable.

In this case report, in order to obtain pure skeletal expansion and unilateral dental Class II correction without anterior anchorage loss or the need for compliance, a single device was constructed after digital planning of miniscrew insertion. The miniscrew positions were carefully planned via accurate matching between the lateral head film, obtained with radiopaque landmarks positioned along the palatine raphe incorporated into a removable retainer, and the digital models in STL format. The surgical guide (MAPA) enabled accurate and secure positioning of the four miniscrews and immediate anchorage and fitting of the appliance in a single sitting. Immediate loading seems to be beneficial for both miniscrew stability and for treatment efficiency.[14]

Although the patient was a young adult, this protocol provided resolution of the left crossbite and the opening of the median suture, as evidenced by the formation of a clinically evident interincisor diastema, testament to a skeletal response to the orthopedic forces exerted. Unilateral distalization of the second quadrant was obtained with no loss of anterior anchorage, and a super Class I molar relationship was achieved, also with the presence of the upper left third molar at the bud stage. Orthodontic drift of the premolars facilitated the correction of the canine classification and reduced overall treatment time. Subsequently, the refinement phase made it possible to refine the occlusion and achieve satisfactory occlusion esthetically and comfortably,[15] although a few more months of finishing could have been considered to obtain even more optimal results.

CONCLUSIONS

- The successful resolution of this case shows how the use of digital planning for miniscrew insertion and the delivery in a single visit of a bone-borne device for expansion and distalization offers a good therapeutic option for patients with advanced skeletal maturity.
- The treatment records demonstrate that the protocol used enabled palatal expansion without resorting to surgery, as well as unilateral distalization without anterior anchorage loss.
- On the other hand, the subsequent use of clear aligner therapy for the finishing phase respects the esthetic and the comfort demands of the young adult patient.

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