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Case Report

Mini-Implant-Assisted En Masse Protraction of Maxillary Posterior Segment

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ABSTRACT

Protraction of posterior teeth to close the spaces in patients with congenitally missing maxillary lateral incisors is challenging. Mini-implants are a reliable source of anchorage for this purpose. This case report demonstrates the application of a T-bar protraction appliance with a palatal mini-implant for en masse protraction of posterior teeth into the lateral incisor space in an adolescent patient. The patient's occlusion and esthetics were significantly improved, and ideal overjet and overbite were obtained after 30 months of treatment. Follow-up records six months after the completion of the treatment displayed stable results.

Keywords: Mini-Implant , 'en masse' protraction, T-bar

INTRODUCTION

Congenitally missing maxillary lateral incisors can be treated either by space closure with canine substitution or by creating additional space for prosthetic restoration (1-4). In young patients, canine substitution can be visualized as a long-term treatment option for missing lateral incisors. However, depending on the type of occlusion, achieving anchorage control can be critical. Mini-implants can provide a reliable source of anchorage for protraction of canine and posterior teeth. The case report presented here demonstrates the application of a T-bar protraction appliance with a palatal mini-implant for en masse protraction of posterior teeth into the lateral incisor space in an adolescent patient.

Diagnosis and Etiology

The patient was a 13.5-year-old boy with a chief complaint of spacing and missing upper front tooth. The extraoral examination showed a convex soft tissue profile with optimal nasolabial angle and coincident facial midline (Figure 1). The maxillary dental midline was deviated 1.5 mm to the left, while the mandibular dental midline was coincident with the facial midline. Intraoral examination showed a Class I molar and Class II canine relationship bilaterally, with 5 mm spacing localized in the maxillary anterior region (Figure 1). The overbite was 1 mm and overjet was 2.5 mm. The maxillary arch was skewed to the left, while the mandibular arch had a symmetric U-shaped arch form. There were no signs or symptoms of temporomandibular joint dysfunction. The upper left lateral incisor was noted to be congenitally missing on the panoramic radiograph (Figure 2). The cephalometric analysis indicated a skeletal Class I jaw relationship with normal mandibular plane angle (Figure 3 and Table 1). The maxillary and mandibular incisors showed mild proclination.

Treatment Objectives

Based on the patient's chief complaint and the problem list, the treatment objectives were as follows: (1) achieve a Class I canine relationship; (2) close the maxillary anterior spaces; (3) establish an ideal overjet and overbite; (4)

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correct the maxillary dental midline deviation; and (5) maintain the facial profile.

Treatment Options and Alternatives

Two treatment options were considered and presented to the patient. The first option was non-extraction orthodontic treatment. In this method, the maxillary anterior spaces would be consolidated and redistributed primarily to the left lateral incisor area. Once the orthodontic treatment was completed, this space would be utilized for replacement of the missing tooth with a prosthesis. The second option was to close the maxillary spaces by protraction of the left posterior teeth with skeletal anchorage. This would require the substitution of the missing lateral incisor and canine with the maxillary left canine and maxillary first premolar, respectively. The occlusion would be finished as Class I molar on the right and Class II molar on the left. After discussion with the patient and the parents, it was decided to protract the posterior segment.

Table 1. Cephalometric analysis

Measurement	Norm	Pretreatment	Posttreatment
SNA (°)	82.0±3.5	79	79
SNB (°)	80.9±3.4	78	78
ANB (°)	1.6±1.5	1	1
FMA (°)	24.4±4.5	24	24
IMPA (°)	95.0±7	93	90
U1-NA (mm)	4.3±2.7	5	6
L1-NB (mm)	4.0±1.8	5	4
Interincisal angle (°)	130.0±6.0	127	132
Upper lip to E-line (mm)	-8.0±2.0	-2.5	-6
Lower lip to E-line (mm)	-2.0±2.0	-1	-4

SNA: Sella, Nasion, A-point; SNB: Sella, Nasion, B-point; ANB: A-point, Nasion, B-point; FMA: frankfor mandibular angle; IMPA: Inter-incisor mandibular plane angle

Treatment Progress

The treatment objectives and alternatives were explained to the patient, and informed consent was obtained. A 0.022×0.028-inch pre-adjusted edgewise appliance was used. The upper arch was leveled with continuous archwires, starting with a 0.016-inch nickel-titanium wire and working up to a 0.019×0.025-inch stainless steel wire in 6 months. A power chain was placed connecting the upper left central incisor to right first molar to shift the dental midline to the right and to consolidate the spaces.

Two mini-implants (2×8 mm) were placed in the palatal area at the premolar level and the impression was taken for construction of a T-Bar protraction appliance. After two weeks, the ap-

Figure 1. Pretreatment facial and intraoral photographs

pliance was delivered and cemented on the incisors and palatal mini-implants (Figure 4). Palatal and buccal power chains were applied for posterior teeth protraction. Grinding and reshaping of upper left canine were performed gradually such that it mimics a lateral incisor during the protraction process. The lower arch was also bonded and banded for some minor corrections. It took approximately 10 months to completely close the space.

At the finishing stage, 0.017×0.025-inch, CNA (Connecticut New Archwire) was used for both arches and inter-arch elastics were worn for occlusal settling. The total treatment duration was 30 months. After the treatment, maxillary and mandibular modified Hawley retainers were delivered.

Treatment Results

At the end of treatment, all the posterior teeth displayed good occlusion and tight interdental contacts. The upper left posterior teeth were protracted by more than 7 mm. The occlusion was finished as Class I canine relationship, with the molar relationship being Class I on the right and Class II on the left side. Normal overjet and overbite were obtained. Posttreatment extraoral photographs showed that dental and facial midlines were coincident (Figure 5).

The posttreatment panoramic radiograph showed good root parallelism with no significant root resorption or bone loss (Figure 6). Superimposition on the cranial base of cephalometric tracings (Figure 7) showed maxillary and mandibular growth changes in the anteroposterior and vertical directions as well as changes in the soft tissue facial profile (Figure 8). Local superimposition of the maxilla and mandible revealed a systematic extrusion of all teeth into the inter-maxillary space created by vertical skeletal growth. The esthetic outcomes of upper anterior teeth were appealing and satisfactory. The patient exhibited a pleasant smile and was happy with the final outcome. Follow-up records six months after the treatment displayed a stable occlusion (Figure 9).

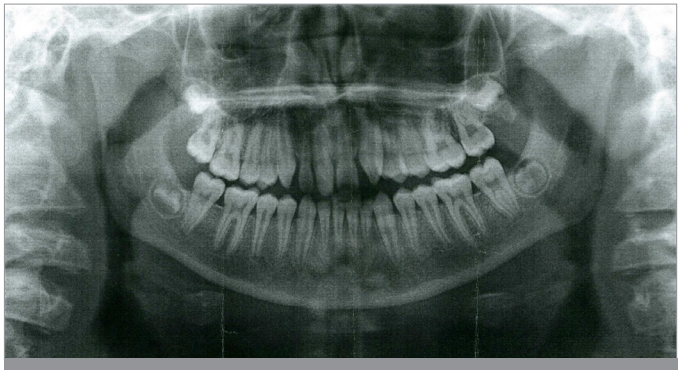

Figure 2. Pretreatment panoramic radiograph

Figure 3. Pretreatment lateral cephalometric radiograph

Figure 4. a, b. Progress intraoral photographs; A: T-Bar was delivered; B: The protraction was completed

Figure 5. Posttreatment facial and intraoral photographs

Figure 6. Posttreatment panoramic radiograph

DISCUSSION

The two primary methods for managing patients with congenitally missing maxillary lateral incisors are orthodontic space closure with canine substitution or creation of additional space for prosthetic restoration of the missing teeth. The factors influencing the choice of treatment include patient age, dental health, buccal occlusion, amount of crowding, and tooth morphology (2-5). An ideal treatment plan should satisfy the patient's aesthetic appearance and functional needs, and at the same time provide a long-term solution to the existing dental and skeletal problems.

Posterior teeth protraction with a canine substitution was therefore the choice of treatment for our patient. Canine substitution has shown better esthetic results and periodontal support (6, 7). De Marchi et al. (8) reported that implant-supported dental prostheses showed less filling by interdental papillae in the spaces between the central and lateral incisors as compared to regular space closure for missing laterals. Canine substitution could be an excellent treatment option for replacing missing lateral incisors with long-term stability and good periodontal health. However, this in no way undermines the fact that treatment decisions have to be made considering several other factors, such as malocclusion, facial profile, and morphology of the canine. Therefore, it does not come as a surprise that opening a space for prosthetic replacement of missing lateral incisors is not a popular choice of treatment. At the same time, this option can lead to a shorter treatment time since midline correction and space opening can be accomplished simultaneously. However, the prevention of alveolar bone resorption and soft tissue shrinkage in the edentulous area should be taken into consideration when an implant-supported dental prosthesis is planned.

Osseointegrated dental implants are unsuitable for adolescent patients because of the active vertical eruption of teeth as ob-

served in this patient. An implant should only be inserted once growth is complete (4, 9, 10). Due to the time lag between orthodontic treatment completion and prosthetic replacement, bone and soft tissue augmentations might be required before implant placement.

Several locations for temporary anchorage devices (TADs), both intra- and extra-dental, have been suggested (11-13). The interdental areas are sometimes unsuitable for TAD placement to protract an entire quadrant because the TADs can themselves interfere with the direction of tooth movement. The anterior palate, at the level between first and second premolars, is a good anatomical site for TAD placement with minimal chances of root perforations (14-16). This site has good bone quality and attached mucosa providing a much higher success rate than most other anatomic locations.

Esthetic Considerations of Canine Substitution

When it comes to replacing congenitally missing lateral incisors, multiple factors should be considered in choosing the appropriate option that satisfies the functional and esthetic demands of the patient. Usually, the options are a canine substitution, implant-supported prostheses, and/or tooth-supported prostheses. The selection of one of these options relies upon different criteria. Considering canine substitution, Kokich et al. (17) have described some criteria that drive the orthodontist more toward choosing such an option. First, the shape and color of the canine must be evaluated carefully. The canine morphology is usually more bulbous, convex, and wider than the lateral incisor when viewed facially. Therefore, a canine with a narrow width, a blunted cusp, and/or less convexity would be more suitable, otherwise extensive restorative workup would be needed. The restorative intervention could be as little as mesial and distal composite build-ups to a full coverage ceramic crown to establish nicely contoured lateral incisors. The color should be also considered because canines are usually 1-2 shades darker than incisors. To manage the color, bleaching is the most conservative option otherwise composite or ceramic veneers can also be considered for more permanent correction. The width of the canine should also be carefully examined mesiodistally at the level of the cementoenamel junction (CEJ). The narrower the canine at the level of the CEJ, the better the emergence profile of the tooth when it mimics the lateral incisor. The second criterion concerns the gingival margin of the canine in relation to both the adjacent teeth and the lip level. Usually, canines have their gingival margins at or slightly incisal to the central incisors. While this usually favors the camouflage of the premolar that is replacing the canine by performing gingivectomy/crown lengthening procedure, it sometimes makes it difficult to manage the canine itself when it replaces a missing lateral since the latter has its own gingival margin about 0.5 mm below the central incisor. Bracket positioning is therefore very critical as placing it based on the gingival margin level will aid the canine to erupt into a better vertical position for a better esthetic gingival outcome.

Figure 7. Posttreatment lateral cephalometric radiograph

In fact, Elaine et al. (18) have found that the morphology, shade, and gingival margin of the canine play a detrimental role in the attractiveness of the treatment outcome. Brighter and narrower canines are more attractive as per the evaluation by orthodontists, dentists, and laypersons. Having a canine gingival margin greater than 0.5 mm above the level of the adjacent central gingival margin was perceived as unattractive.

Kokich et al. (17) also discussed other criteria, such as malocclusion and patient profile. It was mentioned that a straight profile and Class II malocclusion without lower crowding and missing upper lateral incisors were preferred for canine substitution.

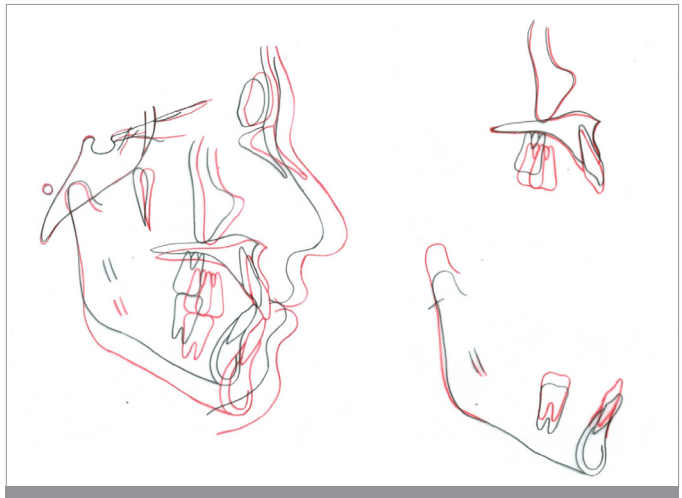

Figure 8. Superimpositions of pretreatment (black line) and posttreatment (red line) cephalometric tracings

Figure 9. Facial and intraoral photographs 6 months after the completion of treatment

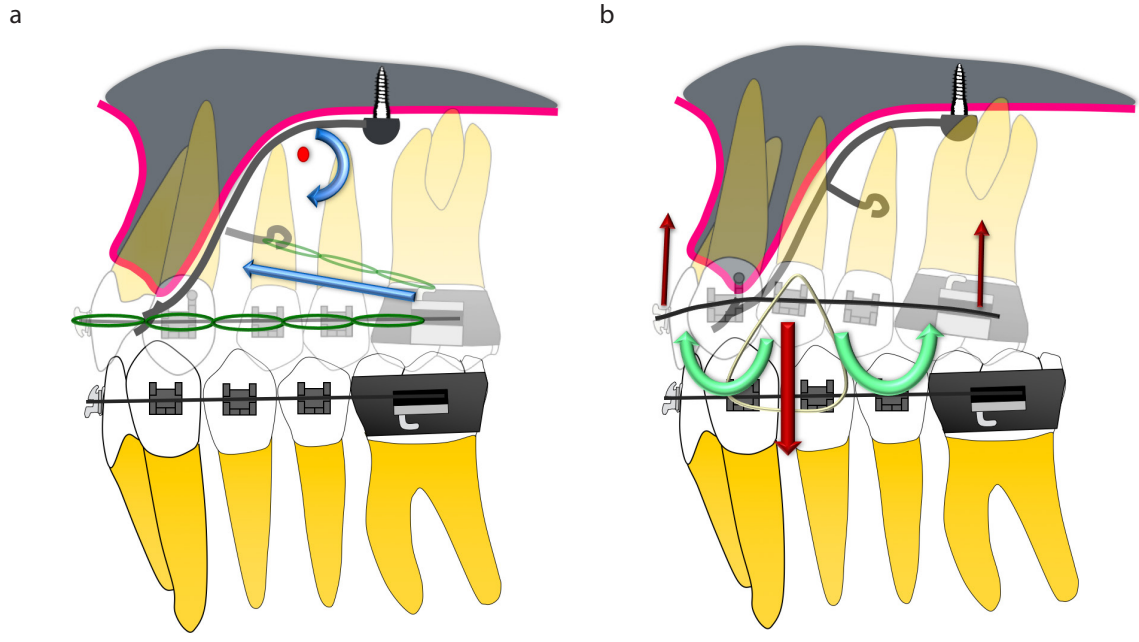

Figure 10. a, b. The protraction force created a clockwise rotation moment causing mesial tipping of posterior segment and lateral open bite (a); The use of vertical seating elastics corrected lateral open bite (b)

Other acceptable indications were a Class I malocclusion with lower crowding that required extractions. The introduction of mini-screws into orthodontics may however allow canine substitution in different malocclusions.

Zachrisson et al. (19) have also pointed out the age of the patient as a critical factor in the selection of the canine substitution option. In a young patient, the orthodontist should provide treatment with very long-term functional and esthetic stability. Provided the shape, color, and the other factors are favorable, early canine substitution will eliminate the need for long-term retention with fixed retainers or semi-permanent bonded bridges before placing an implant at the right age. This will also allow the supporting soft and hard tissue to adapt naturally as the patient grows up.

Rayner et al. (20) stated that unilateral canine substitution cases were found not to be significantly less attractive as compared to bilateral canine substitution cases when smile pictures were evaluated among orthodontists, dentists, and laypersons.

Silveira et al. (21) conducted a systematic review study to compare canine substitution with prosthetic replacement and found that space closure had better scores when evaluated by all the periodontal indices than prosthetic replacement. They further concluded that prosthetic interventions arouse greater criticism in dentists, patients, and laypersons. It was also concluded that canine guidance, whether present or absent in treating such cases, had no relationship with TMDs.

In our opinion, given that most if not all factors are favorable for our patient, canine substitution was the preferred method of treatment

Appliance Biomechanics

A T-Bar protraction appliance helped in securing dual support. A primary direct anchorage was obtained from the palatal side via an extension. This was used for applying a force parallel to the archwire to minimize arch deviations during protraction. A secondary indirect anchorage was derived from the palatal surfaces of incisors by bonding an anterior extension of the main body of the device. This helped in stabilizing the maxillary incisors, which could be used as indirect anchorage to apply protraction force from the buccal side. This type of dual (buccal and lingual) force application helped minimize the transverse rotation of the posterior segment. It also helped in preventing side effects from unilateral forces to the rest of the arch.

From a buccal perspective, both the lingual and buccal forces were significantly away from the assumed center of resistance (Cres) of the posterior segment resulting in a mesial tip during protraction (Figure 10a). To offset this undesirable side effect, a 0.019×0.025-inch stainless steel archwire was used. This archwire helped in generating an uprighting moment on the segment; however, it was not sufficient enough to prevent a mesial moment to cause flexion of the main archwire during protraction. It is critical to remember that the posterior terminal portion of an orthodontic archwire has high flexibility because it is an unsupported cantilever. This complicates the protraction of the entire segment. Mechanically speaking, the load created by the simultaneous tipping of the entire posterior segment resulted in archwire deformation.

Once the space was closed, the second molars were bonded and seating elastics were used to create specific moments in the posterior segment for complete leveling of the teeth with root correction (Figure 10b).

CONCLUSION

This case demonstrated that a T-Bar protraction appliance, when combined with sound biomechanical principles, is an effective modality for protraction of maxillary posterior teeth. Palatal mini-implants exhibited good stability throughout the treatment with no reported patient discomfort.

Informed Consent: Written informed consent was obtained from the patient who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - H.A., M.U., J.F., P.C., S.Y.; Design - H.A., M.U., J.F., P.C., S.Y.; Supervision - J.F., M.U., S.Y.; Fundings - N.A.; Materials - N.A.; Data Collection and/or Processing - H.A., P.C., S.Y.; Analysis and/or Interpretation - H.A., P.C., M.U., S.Y.; Literature Search - H.A., P.C., M.U., S.Y.; Writing Manuscript - H.A., M.U., J.F., P.C., S.Y.; Critical Review - O H.A., M.U., J.F., P.C., S.Y.

Conflict of Interest: The authors have no conflict of interest to declare.

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