CASE REPORT

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Bodily tooth movement through the maxillary sinus with implant anchorage for single tooth replacement

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Abstract: Movement of teeth through anatomic limitations, such as the maxillary sinus, can be a reliable therapeutic protocol if suitable force systems are used. We report here the outcome of a treatment based on this concept. The patient exhibited pneumatization of the maxillary sinus resulting from earlier extractions. She was treated using an endosseous implant inserted in the retromolar region to serve as orthodontic anchorage and a T-loop appliance fabricated from TMA wire to bodily move an upper second premolar through the sinus. After 6 months, at the end of the displacement, a titanium implant was inserted in the alveolus of the moved tooth and a single crown restoration was placed. The premolar moved through the sinus maintaining its support apparatus and bone. At the end of treatment the implant used for anchorage was still osseointegrated.

Key words: anchorage; implant; maxillary sinus; tooth movement; tooth replacement

Introduction

The classical belief holds that a force acting on a tooth generates bone resorption on the pressure side and apposition on the tension side. In this way teeth can be moved until there is bone in the direction of the movement. But this concept must be revised because clinical experience has shown that it is possible to move teeth through the initial anatomic limitations such as sinusal, sutural, or cortical barriers. It has been reported that the conventional concepts of limitation

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imposed on the moving tooth and its relationship with the cortical bone, alveolar process, and maxillary sinus floor can be overcome (1).

Teeth can be moved 'with the bone' or 'through the bone.' To elicit a 'with the bone' type of tooth movement, a direct resorption of bone in the direction of movement must occur, with a balance between resorption and apposition (2, 3). If, as a result of excessive force application, hyalinization occurs then indirect resorption will take place and the tooth will move 'through the bone' without any apposition. Quite often limitations in tooth movement in regions beyond the alveolar process, such as the maxillary sinus, are imposed by incorrectly applied forces. The distribution of orthodontic forces within the periodontal structures is determined by two factors: force level and moment/force ratio at the center of resistance. Force level, especially at the beginning of the treatment and in the adult patient, should be very low in an effort to prevent the formation of areas of hyalinization and to promote the proliferation of periodontal cells (4, 5). However, the clinician must apply these light forces with a high moment/force ratio (6). This way, forces will be appropriately distributed along the periodontal ligament during translation.

Anchorage is the first consideration in the design of any orthodontic appliance, but especially in the adult patient. Recently, oral implants have become reliable therapeutic alternatives where an intra-oral natural anchorage cannot be found. The use of endosseous implants as orthodontic anchors have been reported by previous investigators (7, 8). Based on these reports in the literature, it could be argued that a tooth moved through the maxillary sinus will maintain the original height of the supporting apparatus, the connective tissue attachment and the alveolar bone height. The present clinical study was, therefore, designed to test this hypothesis. We moved a tooth orthodontically using an endosseous implant as anchorage. Finally, a second implant was inserted in the alveolus of the previously moved tooth to support a single crown restoration (9).

Case presentation

The treatment plan for this 24-year-old female patient was to restore the upper left region where all three molars had been extracted. A conventional fixed partial prosthesis was not possible because she had no posterior teeth to serve as satisfactory abutments. Moreover, subsequent to the loss of teeth, the maxillary sinus had been pneumatized, providing no chance for an implant in that area (Fig. 1). Sinus lift augmentation (10) was a consideration but the patient did not want such surgery. It was then decided the second premolar should be moved distally through the maxillary sinus and in its place filled with a titanium implant; this way she would end up with three premolars.

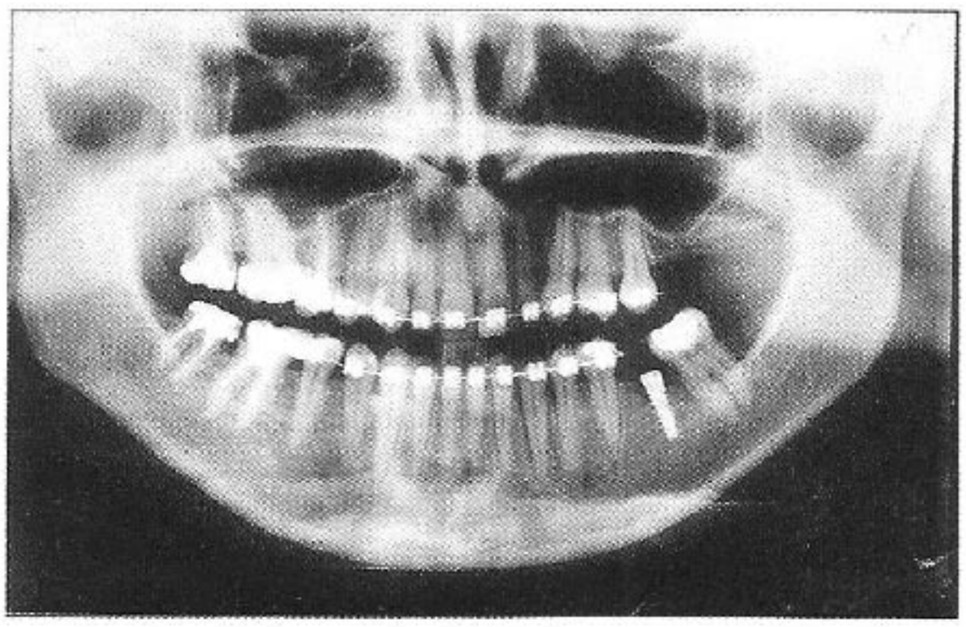

Fig. 1. Initial orthopantogram. Note the pneumatization of the sinus in the left molar area.

For orthodontic anchorage a Screw-Vent® implant (Paragon Implant Company, Encino, CA, USA) of 13 mm in length and 3.75 mm in diameter was inserted in the retromolar area with a two-stage technique. The implant was surgically uncovered 4 months later and the abutment with the temporary crown was attached (Fig. 2). A molar band was cemented around the temporary crown and a 0.017″ × 0.25″ TMA T-loop was placed between the implant and the second premolar,

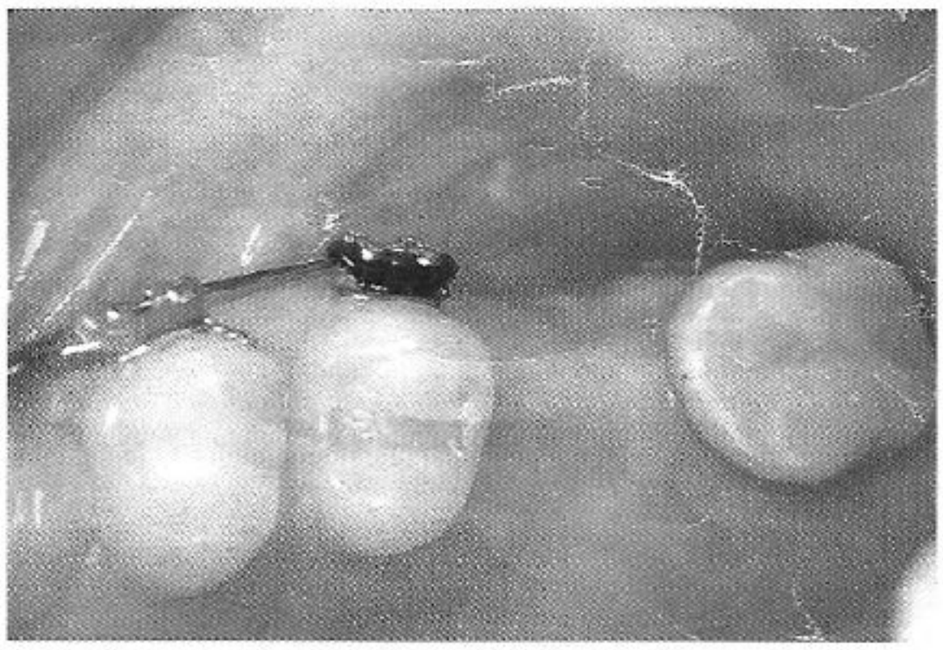

Fig. 2. Occlusal view of the temporary crown connected to the anchor implant.

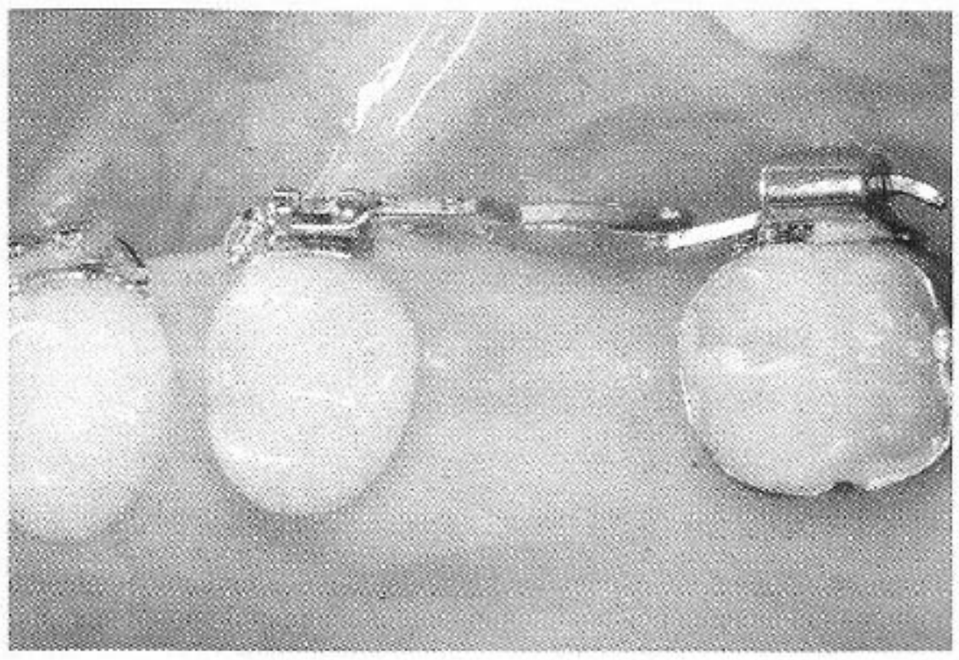

Fig. 3. Intra-oral view of the TMA T-loop acting on the second premolar.

to open a space opening between the two premolars in a segmented arch approach (11) (Fig. 3). The T-loop was characterized by approximately 50 g/mm load/deflection rate. The resulting force line of action passed about 10 mm above the bracket, and the force system in relation to the center of resistance was such that, initially, a controlled tipping occurred. This movement gradually changed into a translation and finally, root movement. The overall movement, however, was a translation (12). During the first period after force application, a rapid space opening was seen because of both tipping and translation, and when a correct mesiodistal inclination was reached the T-loop was reactivated (Fig. 4). About 6 months after the beginning of orthodontic movement a reliable distal translation of the premolar was seen (Figs. 5 and 6). The force system we had designed was estimated to result in tooth displacement of approximately 1 mm/month.

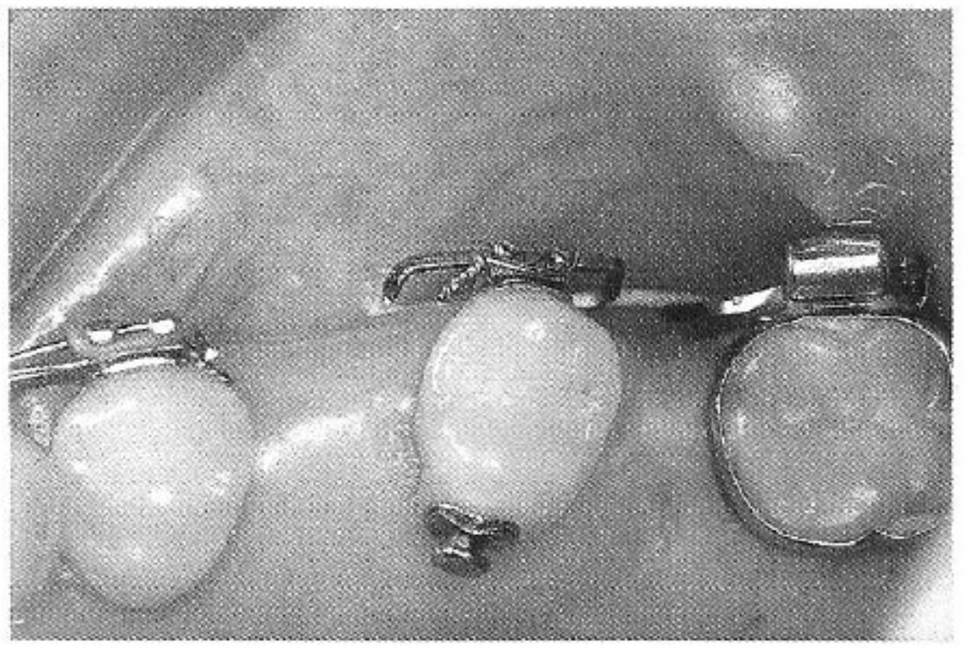

Fig. 5. Intra-oral view showing the completed space opening after 6 months.

At this time an Exacta® implant (Biaggini Ormco Italia, La Spezia, Italy) of 11 mm in length and 4 mm in diameter was inserted in the alveolus area of the second premolar, with a two stage procedure without any sinus lift surgery (Figs. 7 and 8). The orthodontic appliances were used to retain the moved tooth in its new position for another 4 months, corresponding to the implant healing period. After surgical reentry the abutment was connected, and an acrylic resin crown was cemented so to have a final restoration by means of an implant supported single crown (13) (Fig. 9).

Results and conclusion

During treatment a plaque control program (14) was followed and there were no signs of gingival inflammation (i.e., bleeding on probing or increasing on probing depth). The moved tooth always maintained its

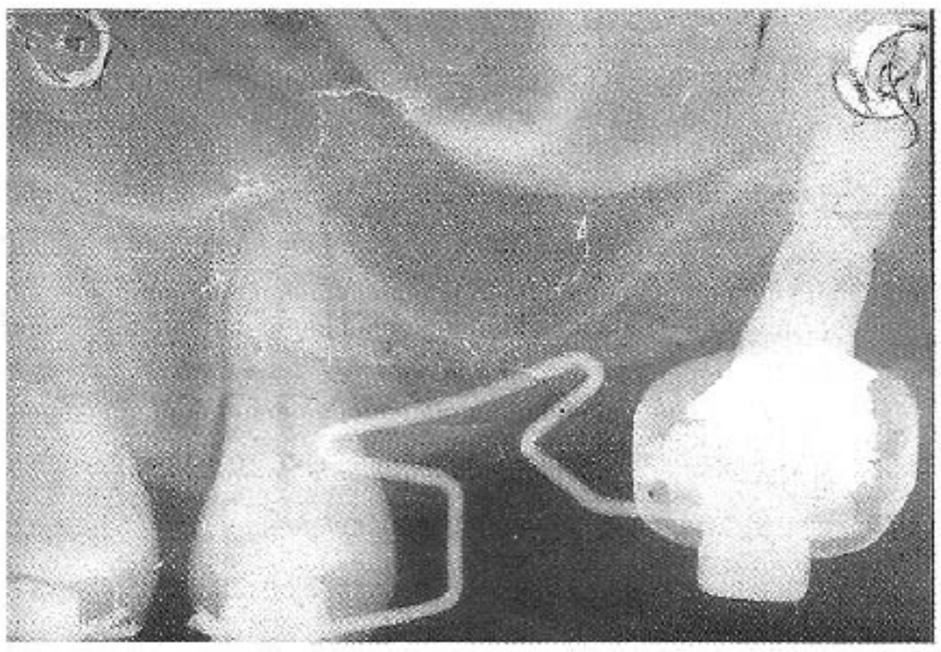

Fig. 4. Radiographic view showing the initial distal movement of the root through the sinus.

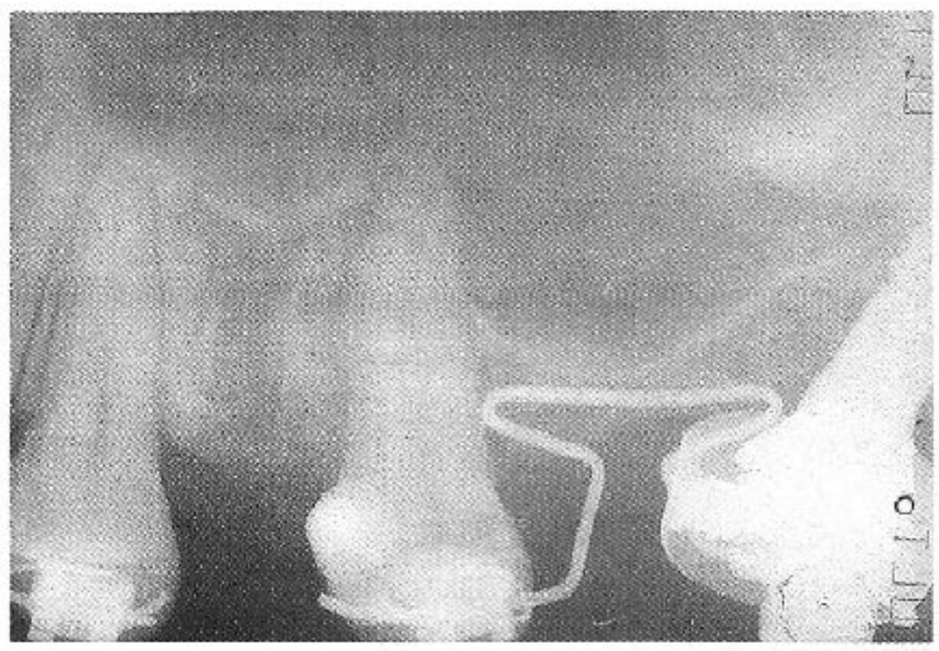

Fig. 6. Radiographic view of the root displaced. Note the remodeling of the sinus contours.

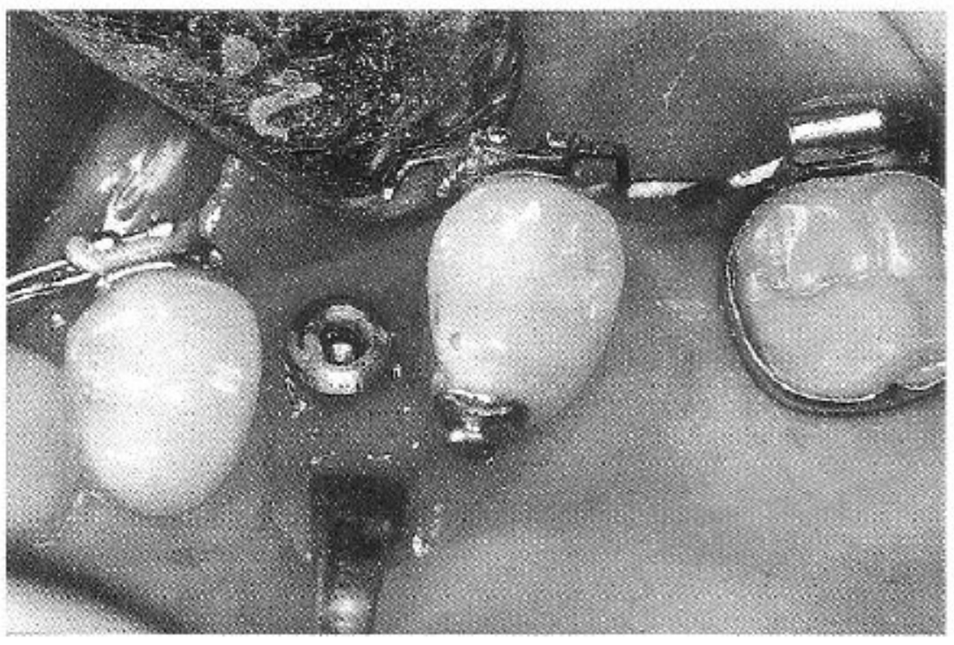

Fig. 7. Clinical view of the insertion of the endosseous implant.

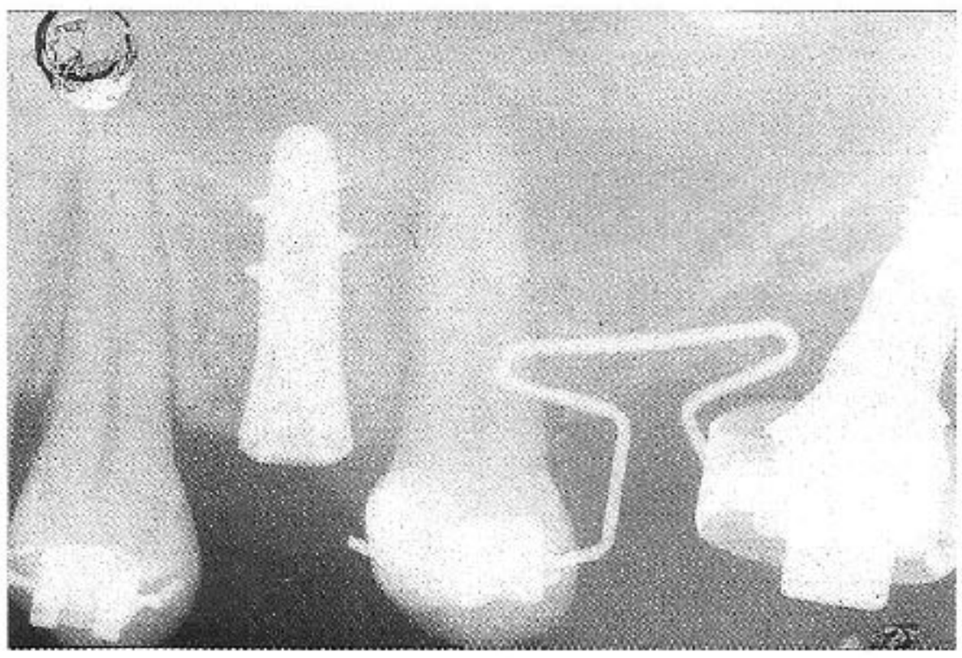

Fig. 8. Radiographic view of the fixture inserted in the premolar alveolus.

Fig. 9. Occlusal view of the temporary crown connected to the implant.

normal vital response to pulp testing during this period. Radiographic evaluation of the displacement revealed that after 6 months of active orthodontics a bodily movement has been achieved with distally translated root, but with no vertical displacement. Direct resorption has allowed the movement even if the sinus floor seemed to set a limit to it. Following the distal movement, direct remodeling has displaced the lamina dura leading to a complete remodeling of the sinus contours.

It seems that the tooth did not fall into the sinus. Instead, it moved with its supporting bone without experiencing any loss of connective tissue attachment. Moreover, this controlled movement has left ample bone for implant insertion into the alveolus of the displaced tooth. The endosseous implant inserted in the retromolar area and used as anchor has maintained its osseointegration at the end of the treatment, fulfilling the standard criteria of success (15). Space opening in the premolar area allowed the insertion an implant supported crown so to increase teeth number and posterior occlusal support. The result of the present clinical case suggest that a tooth with normal supporting apparatus height can be orthodontically moved through the maxillary sinus while maintaining pulp vitality, bone support and exhibiting normal width of the periodontal ligament both on the pressure and on the tension sides (16, 17). It is unfortunate that a histological analysis of the region is impossible. It would have been interesting to study the real space relationship between the root of the displaced tooth, the subperiosteal layer and the sinus recessus (18–22). Nonetheless, clinical findings of this study indicate that with a proper orthodontic force system, a tooth can be displaced through the sinus area, and the sinus lift surgical augmentation procedure can be avoided. Furthermore, implant insertion in a previous alveolus is possible. Our experience presented here suggests that for patients who do not want fixed or removable partial dentures, adjunctive orthodontic tooth movement through the sinus and creation of an alveolus suitable for an implant is a viable alternative. The final restoration will be a single crown with a titanium implant support. This is a biologically acceptable approach (23, 24). We were also able to demonstrate that dental implants can function as orthodontic anchorage for mesiodistal movements (25). The fixture remained stable throughout the 6 months of active force application, with no mobility and minimal inflammation around the abutment, and maintained its rigid osseointegration.

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