CASE REPORT

Orthodontic tooth movement after extraction of previously autotransplanted maxillary canines and ridge augmentation

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A case report is detailed in which autotransplanted maxillary canines were removed and the spaces closed. Substantial surrounding bone loss was associated with the upper right canine, and a bone graft was needed to reestablish normal dentoalveolar ridge morphology. Bone was taken from the maxillary tuberosity and placed in the canine extraction site, fixed with a bone screw, and covered with GoreTex. Seven months after placement of the bone graft, the GoreTex and stabilizing screw were removed to allow for consolidation of the bone. The upper left canine and lower second premolars were extracted, and fixed appliances were placed in both arches to align the teeth and close the spaces. Protraction of the upper right first premolar and retraction of the lateral incisor into the graft site were kept slow and constant with continued periodontal assessment. During the space closure, there was some concern that the bone in the graft site might resorb, leaving the teeth with compromised periodontal support. However, no significant periodontal attachment loss occurred despite ongoing concern about the amount of keratinized tissue. Perhaps the relatively slow rate of tooth movement provided for bone to be maintained and recreated ahead of the tooth. Almost complete closure of the upper canine extraction spaces was achieved. The upper premolars were substituted for the maxillary canines, and unfavorable prosthetic options were thus avoided. The lower arch was aligned, and the extraction spaces completely closed. (Am J Orthod Dentofacial Orthop 2000;118:699-704)

Little has been published concerning orthodontic tooth movement through bone graft sites after ridge augmentation. The biological aspects of tooth removal relating to bone turnover have been recently reviewed.[1-4]

For many years, clefts of the palate have been successfully managed with secondary bone grafting with subsequent canine positioning by means of passive eruption or orthodontic traction into the graft site.[5,6] In a study of cleft cases in which orthodontic traction was applied to position a surgically exposed canine into the graft site, a greater amount of attachment loss occurred compared with canines that erupted without assistance into position.[7]

Orthodontic tooth movement after the use of resorbable bone graft material to repair surgically created alveolar ridge defects in cats has been described.[8] Tooth movement, initiated 6 weeks after bone graft placement, occurred in equal degrees in the grafted sites and nongrafted sites. However, the long-term periodontal status of teeth moved into the graft sites was not assessed.

A variant of guided tissue regeneration is the restoration of lost bone around implants or in constricted bone areas in preparation for implantation.[9] This guided bone regeneration as opposed to guided tissue regeneration might be useful for orthodontic movement of teeth into an atrophied alveolar process. Experimental reports and clinical studies would seem to indicate that areas of decreased vertical bone height should not be a contraindication for orthodontic tooth movement.[10,11] The guided bone regeneration technique of bone augmentation provides an exciting new field for further orthodontic investigations.

The case presented here involved removal of unsatisfactory autotransplanted maxillary canines associated with substantial surrounding bone loss; it required a bone graft to reestablish the normal dentoalveolar ridge morphology. Factors pertaining to the autotransplantation of teeth have been recently reviewed.[12]

PATIENT HISTORY AND PRESENTATION

The patient presented for orthodontic assessment in March 1993 at the age of 17 after referral by her general dentist for assessment of unsatisfactory autotransplanted maxillary canines. When she was 15, she had gone to an oral surgeon with both maxillary canines palatally positioned and unerupted. Her medical history was uneventful.

Two retained deciduous canines were removed and the permanent maxillary canines were transplanted into the prepared deciduous extraction sites.

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Submitted, July 1999; revised and accepted, November 1999.

0889-5406/2000/$12.00 + 0 **8/4/104490**
doi:10.1067/mod.2000.104490

Fig 1. Pretreatment facial photographs.

Fig 2. Pretreatment cephalometric radiograph.

Table I. Pretreatment and posttreatment cephalometric values

Measurement	*Std*	*Pretreatment*	*Posttreatment*
SNA	82	84	84
SNB	80	78	77
ANB	2	6	5
Facial Axis BaN-Ptm, Gn	90	89	90
Md Plane FH-Go, Me	26	24	25
LFH ANS-Xi-SPog	47	40	40
11,21 — ANS, PNS	109	108	106
31,41 — Go, Me	90	93	93
31,41-APo	1	0	0
Lower lip-E plane	-2	-2	-4

Md Plane, Mandibular plane angle; LFH, lower face height.

No endodontic monitoring or treatment was undertaken, and the patient went to her general dentist concerned about some discomfort and the adverse appearance of the upper right canine. As an initial measure, the general dentist managed the symptoms by means of extirpation of the pulp. She was then referred for orthodontic consultation.

DIAGNOSIS

The patient demonstrated a Class II skeletal relationship with an ANB angle of 6°; the SNA angle was 84°, and the SNB angle was 78°. She was of mesofacial form with a brachyfacial tendency. The mandibular plane angle (FMA) was 24°, and the lower facial height (ANS-Xi-SPog) was 40°. The incisor relationship was almost Class I with an overjet of 3 mm and overbite of 4 mm. The lower incisors were at 93° to the mandibular plane with the incisor tip lying on APo. Soft tissue esthetics were acceptable, and the lower lip was positioned 2 mm behind the esthetic (E) plane (Figs 1 and 2; Table I). Both the left and right molars were in Class II relationships. Crowding in both arches was mild to moderate: 3 mm in the upper arch and 4 mm in the lower arch. Of note, the upper right canine was nonvital with poor periodontal support on the buccal aspect. The upper left canine was positioned in the arch with excessive palatal root torque. Neither of the upper canines were in functional occlusion; the upper right canine was in mild crossbite, and the upper left canine crown was

Fig 3. Lateral and frontal views of the dentition at initial presentation.

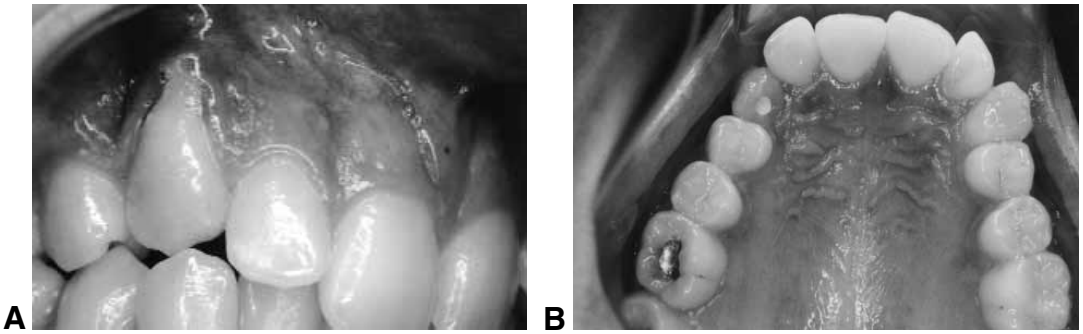

Fig 4. A, View of the upper right canine illustrates poor periodontal health with loss of support; **B**, maxillary occlusal view.

Fig 5. Pretreatment periapical radiograph of the upper right canine.

buccally inclined. The clinical intraoral presentation is shown in Figs 3 and 4; the radiographic appearance of the upper right canine is shown in Fig 5. There was a question as to whether the upper left canine would also require full endodontic treatment and the possibility of ankylosis.

Fig 6. Bone graft in position, stabilized with bone screw, before placement of GoreTex.

TREATMENT PLAN

After orthodontic and periodontic evaluation and a discussion with the oral surgeon who performed the autotransplants, a decision was made to treat with full fixed appliances incorporating extraction of upper canines and lower second premolars, together with the third molars. Examination of the upper right canine revealed that a substantial bony defect, with loss of the buccal cortical plate, would be present after extraction, and thus a bone graft to augment the ridge was planned. It was felt that the size of the defect would be

Fig 7. Posttreatment facial photographs.

Fig 8. Posttreatment cephalometric radiograph.

beyond the ability of tissues to remodel if the space was closed without a graft. In addition, there was the risk of significant loss of attachment of the adjacent teeth moved into the graft site if remodeling did not occur; tooth loss was probable.

Orthodontic treatment was to be directed at consolidating and aligning the upper and lower arches with the upper first premolars to take the place of the upper canines. Examination of dental casts revealed a Bolton's discrepancy with excess tooth size in the lower incisor region. It was envisaged that the discrepancy would be marginally worse with the slightly smaller upper premolars substituting for the canines.

After discussion with the patient and her family, a decision was made to not extract the other teeth until the graft was thought to be successful after postoperative monitoring. If the graft was unsuccessful, a prosthodontic option to replace the upper right canine was planned. This approach was very reassuring to the patient, who after her previous dental experience, was reticent to undertake further comprehensive therapy. Orthodontics was clearly the best option. The alternative option of an implant was also dependent on the success of a bone graft with the added disadvantage of most likely needing a replacement at least once during the patient's lifetime. A bridge would involve the lateral incisor and place undue stress on the smaller root.

TREATMENT PROGRESS

The extraction of the upper right canine, bone graft, and removal of third molars were performed under general anesthesia in July 1993. At surgery it was confirmed there was virtually no buccal bone support to the upper right canine. Removal of the canine after a full mucoperiosteal flap resulted in a significant bony defect. Bone was taken from the maxillary tuberosity, placed in the canine extraction site, and fixed with a bone screw (Fig 6). The corticocancellous graft was covered with Gore-Tex (W. L. Gore and Associates, Newark, Del), and the flap sutured to obtain full tissue coverage of the Gore-Tex. The upper left canine and lower second premolars were left in place. Review by

Fig 9. Lateral and frontal views of the dentition 2 years after deband.

the oral surgeon 3 months later revealed an exposed edge of Gore-Tex; this was removed and the soft tissues resutured. Seven months after placement of the bone graft, the Gore-Tex and stabilizing screw were removed to allow for consolidation of the bone.

Clinical assessment of the graft indicated it was acceptable, and arrangements were made for extraction of the upper left canine and lower second premolars. The surgeon performing the extractions noted that the upper left canine appeared to be ankylosed. Upper and lower fixed appliances (0.018-in edgewise) were placed in July 1994, approximately 5 months after removal of the stabilizing screw and Gore-Tex. At this time, the patient was given local anesthesia and bone sounding was performed to verify the level of regeneration in the upper right canine site. There appeared to be solid bone in this site, however, a buccal-palatal discrepancy of between 2 to 3 mm still existed. The keratinized tissue on the buccal aspect of the upper right first premolar was narrow (1.5 to 2 mm) and appeared friable and thin. No significant probing depths were noted on the upper right lateral incisor or first premolar. Probing evaluations throughout the study were done with a pressure sensitive probe.

Leveling and aligning were achieved with 0.012- and 0.016-in Nitinol archwires. Upper and lower space closure was performed with 0.016 × 0.016 inch stainless steel archwires by means of sliding mechanics with elastomeric chain.

Protraction of the first premolar and retraction of the lateral incisor into the graft site were kept slow and constant with continued periodontal assessment. During the space closure, there was some concern that the bone in the graft site may resorb and leave the teeth with compromised periodontal support. However, no further periodontal attachment loss occurred despite ongoing concern regarding the amount of keratinized tissue. Good oral hygiene was maintained throughout treatment. It may be that the relatively slow rate of tooth movement provided for bone to be maintained and recreated ahead of the tooth giving a most satisfactory, and to date, stable result.[11]

Fig 10. Posttreatment periapical radiograph of the upper right canine region.

The treatment mechanics were a little more demanding than the usual case, having to manage closure of canine extraction sites. The upper incisors served as anchorage for protraction of the premolars and molars. The patient had the appliances removed in February 1997, 30 months after placement. The incisors and buccal segments were in Class I relationships. There were residual spaces between the upper lateral incisors and first premolars; these were not unexpected in view of the Bolton's discrepancy and were managed with composite additions. A maxillary cirumferential retainer and mandibular spring retainer were placed.

RESULTS

The posttreatment facial appearance and cephalometric radiograph are shown in Figs 7 and 8. Fig 9

shows the occlusion 2 years after debanding. Significant closure of the upper canine extraction spaces was achieved. The radiographic appearance of the graft site is illustrated in Fig 10. There were no significant bone changes in the interproximal areas of the upper right first premolar or lateral incisor. It is not possible to draw any conclusions from the radiographs about the quality and quantity of labial bone. Clinically, there was no evidence of attachment loss. Although the space between the upper right lateral incisor and first premolar appears large in the radiograph, this is a result of distortion; the space actually measures 1.5 mm. The lower arch was aligned, and the extraction spaces completely closed. Examination of the posttreatment orthopantomogram reveals root parallelism with good morphology and no significant resorption. The pretreatment and posttreatment cephalometric analyses are outlined in Table I. Vertical control of the skeletal pattern was maintained, whereas the anteroposterior Class II skeletal discrepancy was unchanged. The lower incisors were maintained in their pretreatment relationships to the mandibular plane and APo. The upper incisors were retracted. There was an increase in the lower lip to E-plane distance, and superimposition of the cephalometric radiographs indicates this was largely due to growth of the nose. Despite the mild increase in lip retrusion, the clinical facial esthetics posttreatment are excellent.

RETENTION

The patient has worn the removable retainers on a part-time basis since debanding, and checks have occurred over the last 2 years.

FINAL EVALUATION

Treatment objectives have been achieved. The premolars have been substituted for the maxillary canines, and the unfavorable prosthetic options have been avoided. Maintenance of the composite additions should be undemanding and, for the patient, cost-effective compared with the alternative prosthetic options. The occlusion is acceptable, and the dentofacial esthetics are also much improved. Acceptable tooth positions to reference cephalometric landmarks have been obtained, despite the increased complexity of the upper canine extractions. The patient has maintained regular retainer check visits and periodic preventive dental check-ups. The present case underpins the importance of a multidisciplinary approach to complex problems. Had the patient been examined by an orthodontist before the autotransplantations, an alternative conservative approach could have been used from the outset. The patient's unhappiness with her dental appearance would have suggested a course of orthodontics. This would have most likely involved surgical exposure of the canines with orthodontic traction to align into the arch, together with extraction of the retained deciduous canines, upper first premolars and lower second premolars. If the canines were unfavorably located, extraction of the permanent and deciduous canines and the lower second premolars would have allowed for a routine orthodontic extraction approach.

REFERENCES

1. Collett T. The biology of tooth movement. In: Fricker J, editor. Orthodontics and dentofacial orthopaedics. A comprehensive textbook. Canberra: Tidbinbilla Publishers; 1998. p. 349-76.
2. Hill PA. Bone remodelling. Br J Orthod 1998;25:101-7.
3. Roberts WE. Bone physiology, metabolism, and biomechanics in orthodontic practice. In: Graber TM, Vanarsdall RL Jr, editors. Orthodontics: current principles and techniques, 2nd edition. StLouis: Mosby; 1994, p.193-234.
4. Sandy JR. Signal transduction. Br J Orthod 1998;25:269-74.
5. Hinrichs JE, El-Deeb ME, Waite DE, Bevis RR, Bandt CL. Periodontal evaluation of canines erupted through grafted alveolar cleft defects. J Oral Maxillofac Surg 1984;42:717-21.
6. Silva Filho OG, Okada HY, Capelozza Filho L, Suguimoto RM. Orthodontic traction of a permanent canine through a secondary bone graft in a unilateral cleft lip and palate patient. J Clin Orthod 1998;32:417-22.
7. Eldeeb ME, Hinrichs JE, Waite DE, Bandt CL, Bevis R. Repair of alveolar cleft defects with autogenous bone grafting: periodontal evaluation. Cleft Palate J 1986;23:126-36.
8. Sheats RD, Strauss RA, Rubenstein LK. Effect of resorbable bone graft material on orthodontic tooth movement through surgical defects in the cat mandible. J Oral Maxillofac Surg 1991;49:1299-303.
9. Buser D, Dula K, Belser U, Hirt H-P, Berthold H. Localised ridge augmentation using guided bone regeneration. Int J Perio Rest Dent 1993;13:29-45.
10. Hom BM, Turley PK. The effects of space closure of the mandibular first molar area in adults. Am J Orthod 1984;85:457-69.
11. Lindskog-Stokland B, Wennstrom JL, Nymann S, Thilander B. Orthodontic tooth movement into edentulous areas with reduced bone height: an experimental study in the dog. Eur J Orthod 1993;15:89-96.
12. Thomas S, Turner SR, Sandy JR. Autotransplantation of teeth: is there a role? Br J Orthod 1998;25:275-82.