Case Report

Corticotomy-assisted molar protraction with the aid of temporary anchorage device

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ABSTRACT

This case report describes the interdisciplinary management of a 58-year-old woman who was missing lower first molars and supraerupted maxillary first molars. The treatment plan included intrusion of the upper first molars and corticotomy-assisted mandibular second molar protraction with the aid of temporary anchorage devices. Miniscrews were effective in intrusion of the maxillary first molars and protraction of the lower second molars. Although good functional outcome was achieved in 41 months, the corticotomy-assisted procedure did not significantly reduce the treatment time. (*Angle Orthod.* 2013;83:1083–1092.)

KEY WORDS: Corticotomy; Molar protraction; Miniscrew

INTRODUCTION

Permanent mandibular molars are the most commonly missing teeth in adults.[1] The treatment of choice in patients with single missing teeth is either a fixed three-unit bridge or an endosseous dental implant. Alternatively, orthodontic space closure of a remodeled edentulous space by second molar substitution for missing first molars is a viable treatment option if adequate anchorage is established. Temporary anchorage devices are effective in providing absolute anchorage for second molar protraction and thereby preventing unwanted side effects in the anterior segment.[2]

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Technological advances in orthodontics are primarily aimed at reducing treatment time, reducing postoperative pain, and enhancing periodontal health. Treatment time for space closure by second molar protraction in adults ranges from 2 to 4 years,[3] as the rate of tooth movement depends on bone density, turnover rate, and hyalinization of the periodontal ligament.[4,5] In the adult patient, there is reduced cellular activity and increased bone density, and hyalinized zones are formed more readily on the pressure side, thereby reducing the tooth movement and increasing treatment duration.[6] To reduce the treatment time, different treatment approaches have been reported with some degree of success in animal and clinical studies. Some of these procedures include use of lasers[7] or electrical stimulation,[8] vibration,[9] corticision,[10] piezoincision,[11] corticotomies,[12] and osteotomies.[13]

Periodontally accelerated osteogenic orthodontics (PAOO) is a modified approach involving corticotomies and particulate bone allografts, which has been reported[14] to enhance the rate of tooth movement by increasing alveolar bone turnover and reducing bone density. This case report describes the interdisciplinary management of an adult patient with a PAOO approach for bilateral second molar protraction using miniscrews for anchorage.

CASE REPORT

Diagnosis

A 58-year-old female was referred by her prosthodontist for orthodontic protraction of the mandibular

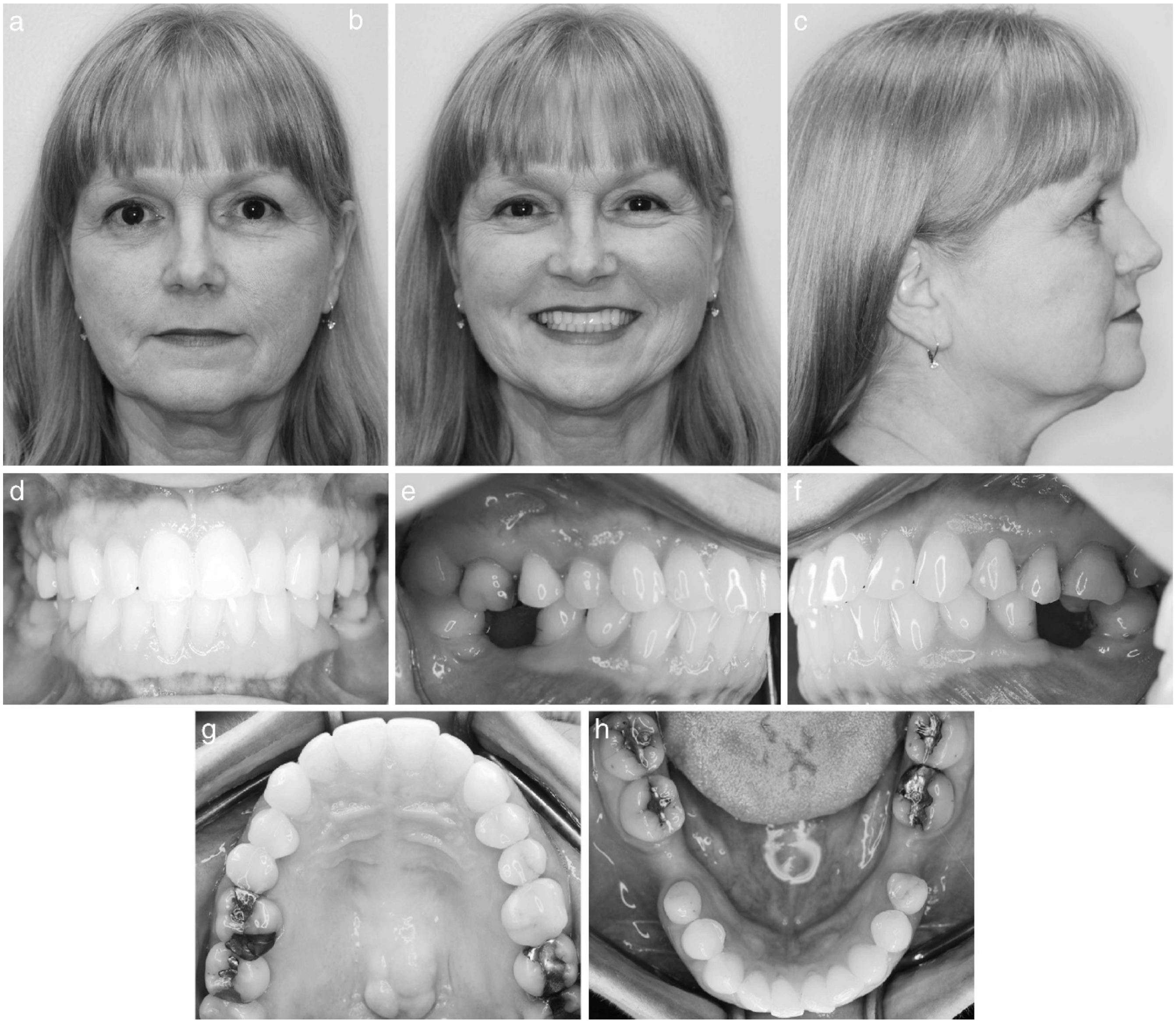

Figure 1. Pretreatment photographs.

second molars into bilateral atrophied edentulous spaces of the first molar sites. The patient sought treatment to relieve the mandibular anterior crowding and to close the missing lower first molar space. Medical history reflected that the patient was diabetic but that her diabetes was under control with diet only, and the patient was taking Lipitor (20 mg/d). Extraoral examination showed no gross skeletofacial asymmetry, competent lips at rest, and orthognathic profile with normal nasolabial angle (Figure 1).

Upon intraoral examination, overjet and overbite were normal, and a Class I canine relationship on both sides, with mild crowding in the lower anterior teeth, was evident. Both of the lower first molars had been extracted at an early age, and considerable remodeling of the alveolar ridge was seen both buccolingually

Table 1. Cephalometric Measurements

Variable	Norm	Pretreatment	Posttreatment
SNA, °	82	78	78
SNB, °	80	80	81
ANB, °	2	−2	−3
MP-SN, °	32	31	30
Interincisal angle, °	130	115	125
U1-SN, °	102	117	116
U1-NA, °	22	37	36
U1-NA, mm	4	9	8
L1-NB, °	25	28	20
L1-NB, mm	4	6	4
IMPA, °	95	96	90
Lower lip to E-plane, mm	−2	−6	−6
Upper lip to E-pane, mm	−6	−7	−6

Figure 2. Pretreatment lateral cephalometric radiograph.

and vertically. The second molars had slightly tipped mesially into the extraction space. The edentulous space mesial to the mandibular molars measured 8 mm bilaterally. The maxillary first molars had supraerupted into the extraction space bilaterally. Cephalometrically, the patient presented with a straight skeletal profile (Figure 2; Table 1). The periapical radiographs showed slightly increased bone loss in the posterior dentition (Figure 3).

Treatment Objectives

The treatment objectives were to orthodontically close the space generated by the missing mandibular first molars, relieve lower anterior crowding, and intrude the maxillary first molars.

Treatment Alternatives

Three treatment options were considered for this patient, as follows:

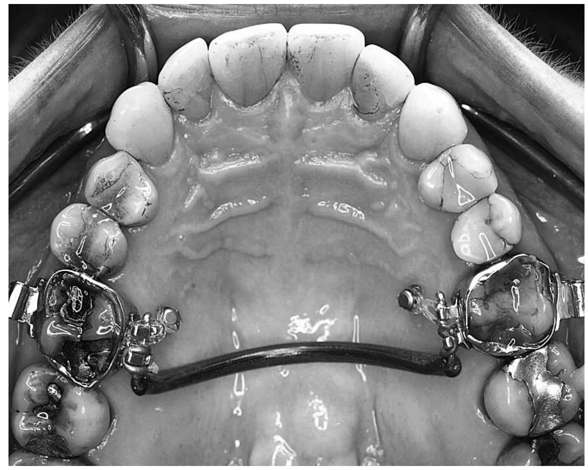

Figure 4. Miniscrews for intrusion of maxillary first molars.

1. Intrusion of maxillary first molars with the aid of miniscrews, followed by restoration of missing mandibular first molars with endosseous implant–supported prosthesis after orthodontic space appropriation.
2. Space closure of the edentulous mandibular first molar space by protraction of the mandibular second and third molars aided by miniscrew anchorage. Additionally, miniscrews were to intrude both first maxillary molars to the occlusal plane.
3. Corticotomy-assisted second molar protraction as a possibility to reduce the treatment time with this procedure in addition to miniscrew-supported maxillary first molar intrusion.

All three treatment alternatives were discussed with the patient, who selected the third option, as it addressed her chief concern, with a potential reduction in the overall treatment time with orthodontic appliances.

Treatment Progress

The patient received clearance from the periodontist to initiate orthodontic treatment. Miniscrews (1.8 × 8 mm, Orlus, Suntech City, Kyunggi-do, South Korea) were placed palatally between the maxillary first molars and second premolars (Figure 4). A transpalatal arch was fabricated from 0.032-inch, beta-titanium wire to

Figure 3. Pretreatment full-mouth periapical views.

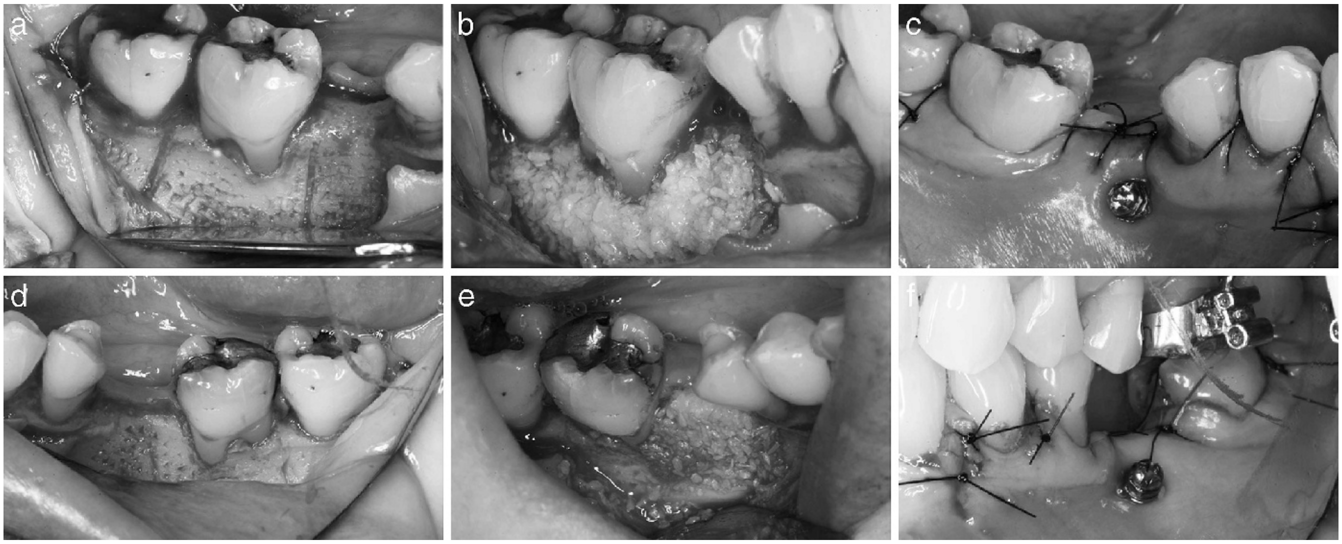

Figure 5. Selective decortication with bone grafting.

Figure 6. Molar protraction from mini-implant.

Figure 7. Treatment progress.

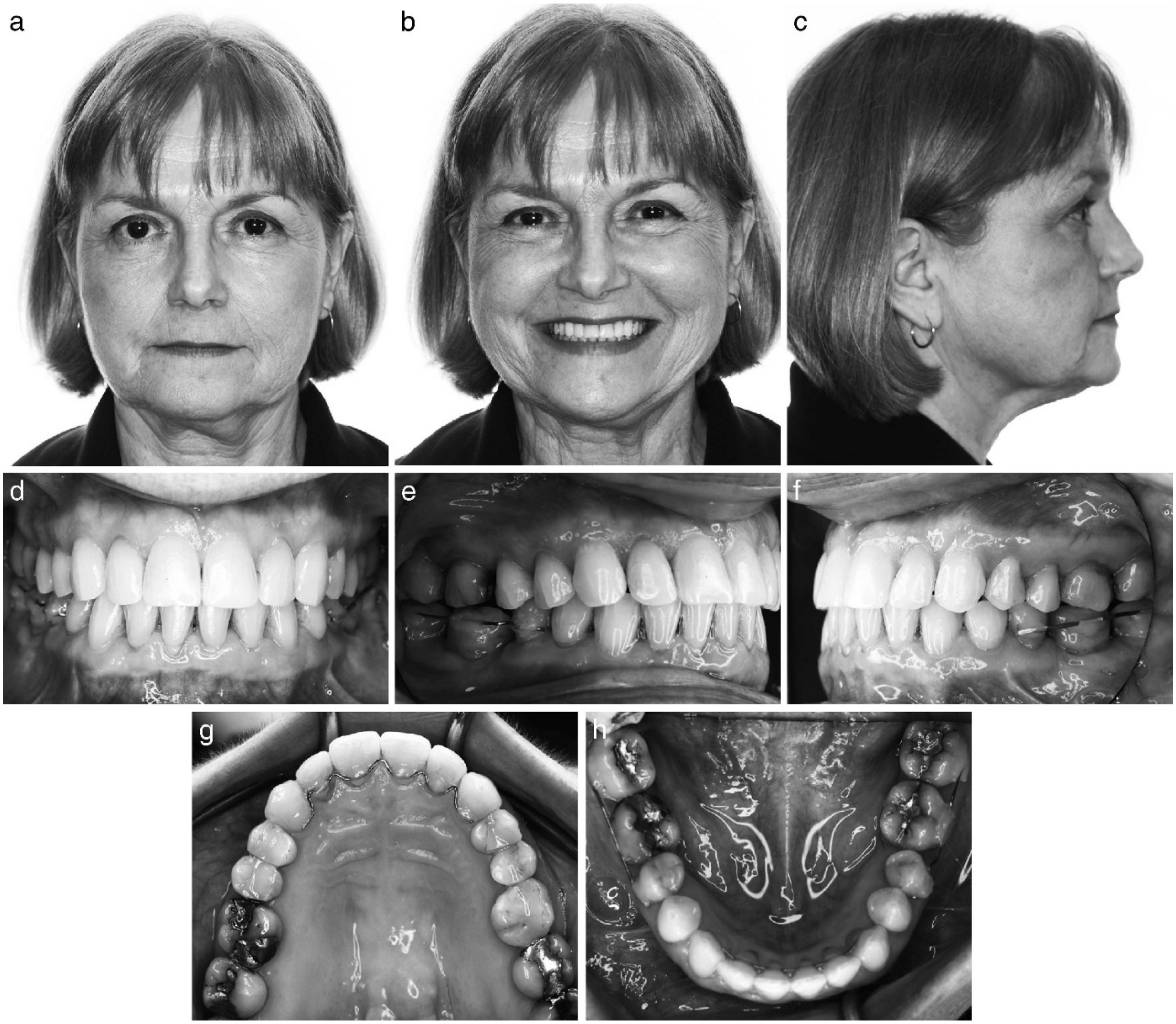

Figure 8. Posttreatment photographs.

prevent palatal tipping of the first molars. Intrusion of the maxillary molars was started with elastomeric chain. Two months later, corticotomies with labial particulate bone allograft were performed. Specifically, bilateral full-thickness buccal flaps were raised from the mandibular first premolar to the third molar. Selective decortication was done on the buccal cortical plate over the second molars (Figure 5), followed by bone grafting (DFDBA) over the decorticated plate. One week after surgery a lingual arch (0.032-inch stainless steel) was cemented on the mandibular second molars. Molar tubes were bonded on the lower third molars, and 0.016 × 0.022–inch stainless-steel segmental wire was placed between the molars. One 1.6 × 8–mm (Dual Top TAD, RMO, Denver, Colo) miniscrew was placed distal to the lower second premolars on each side. Closed nickel-titanium coil springs were activated initially to deliver 150–200 g of force and applied from the miniscrew (Figure 6) to the third molars.

After 6 months, the lingual arch was removed and the lower arch was bonded with 0.022-inch slot MBT brackets (3M Unitek, Monrovia, Calif). After 14 months in treatment, 3 mm of space was still present distal to the second premolars. Miniscrews (1.4 × 8 mm, Vector, TAS, Ormco, Orange, Calif) were replaced between the lower premolars as the miniscrews distal to the lower premolars were in close proximity to the roots of the second molars. The maxillary arch was bonded (Figure 7) and a 0.016-inch nickel-titanium archwire was placed. In order to maintain the molar intrusion, a ligature wire (0.0010-inch stainless steel) was tied from the miniscrew to the maxillary first molar.

Figure 9. Posttreatment lateral cephalometric radiograph.

After 32 months, space closure was complete on both sides. The patient was debonded (Figure 8) after 41 months of treatment. Permanent lingual retainers (0.0175-inch beta-titanium) were bonded on the upper and lower anteriors, and to prevent space opening, fixed sectional wires were bonded with 0.019 × 0.025–inch stainless-steel wire on the buccal surface of the lower second premolars and molars.

Treatment Results

The patient was satisfied with the treatment outcome; however, the treatment time was longer than

Figure 11. Posttreatment panoramic radiograph.

one would have anticipated after corticotomy-assisted tooth movement. A Class I molars and canine relationship was achieved with good alignment and ideal overjet and overbite. Posttreatment cephalometric (Figure 9) analysis showed (Table 1) a slight decrease in the mandibular plane angle, a decrease in soft tissue convexity, and an increase in interincisal angle. The superimposition (Figure 10) of pretreatment and posttreatment cephalometric radiographs clearly showed intrusion of the maxillary molars followed by molar protraction, which leveled the occlusal plane, allowing slight autorotation of the mandible and slightly increasing the chin prominence.

Crestal bone loss mesial to the third molars, especially on the left side, can be appreciated on the panoramic radiograph (Figure 11). Additionally, widened periodontal ligament space was still observed mesial to the right mandibular second molar at the end of treatment. When the patient reported for retention checkup after 5 months, intraoral periapical radiographs of the mandibular molars revealed a slight

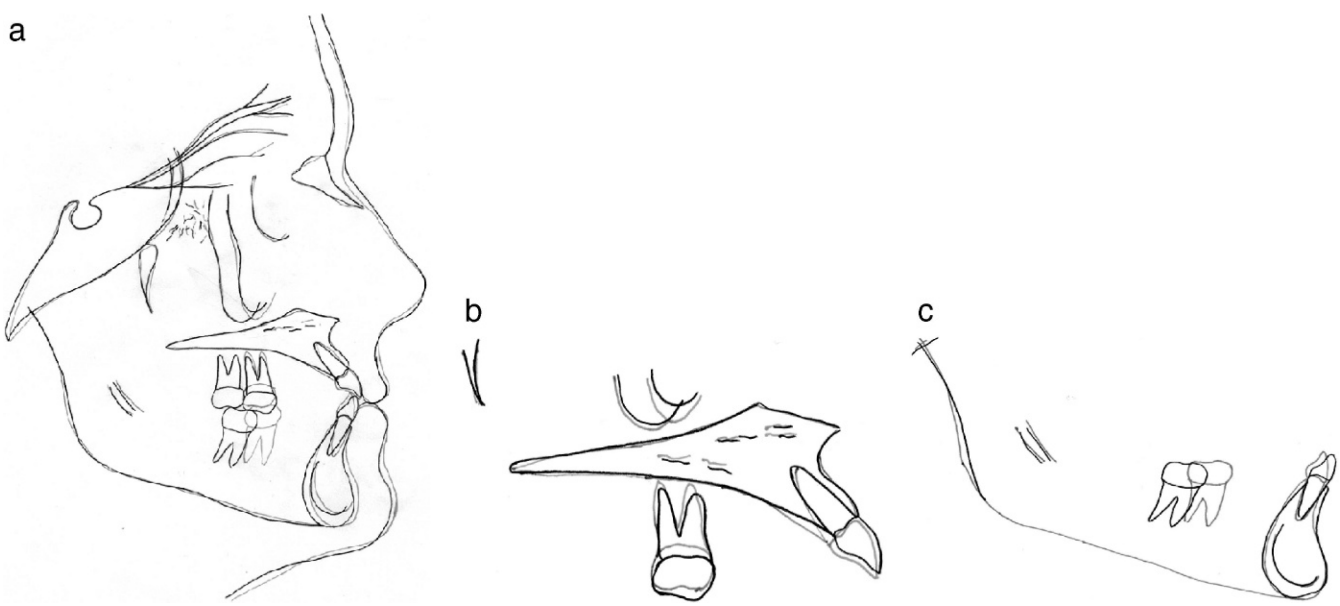

Figure 10. Overall and regional superimposition.

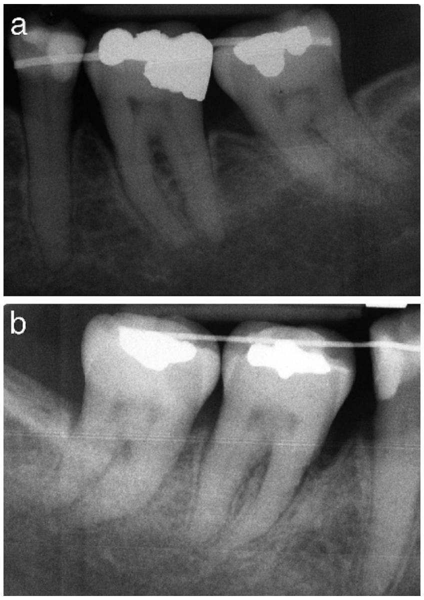

Figure 12. Periapical radiographs of mandibular molars 5 months into retention.

angular bone defect on the mesial aspect of the right second molar (Figure 12). At the 1-year followup the bone levels were maintained, with slight reduction of the angular defect and better definition of the cortical bone (Figure 13).

Some mild external root resorption was noted apically at the right maxillary first molar and mesially at the alveolar crest area of the mandibular right second molar. Mild apical root resorption after molar intrusion has been reported previously[15,16]; however, root resorption in the mesial aspect after significant molar protraction has not been a finding in clinical reports.[5,17] Interestingly, although the orthodontic movements were applied similarly between the right and left sides, the left side did not present these changes. Moreover, at the 5-month and 1-year followup appointments, resorption on the mesial aspect of the mandibular molar showed signs of repair in the periapical radiograph.

The bonded mandibular buccal segment wire on the right side broke and had to be replaced. A small space of less than 1 mm opened soon after. A new bonded wire was placed, and no further opening of space was seen after 1 year (Figure 14).

DISCUSSION

Closure of a missing mandibular first molar space with conventional mechanics has been reported to be challenging as a result of the greater root surface area of the molar, dense bone in the mandible, and significant anchorage requirements. Stepovich[18] and Hom and Turley[3] evaluated the changes in edentulous

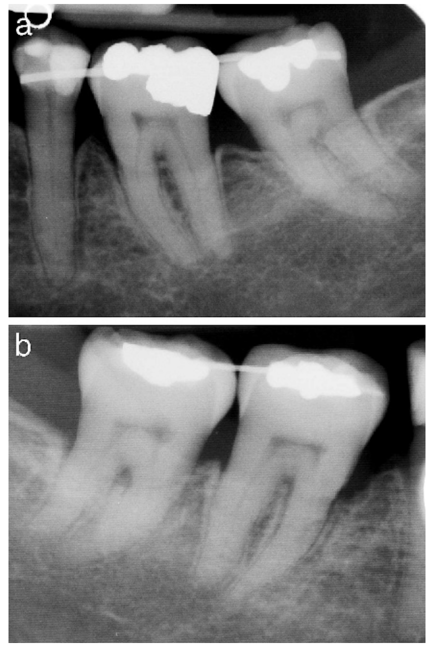

Figure 13. Periapical radiographs of mandibular molars 1 year into retention.

mandibular ridge prior to and after closure of lower first molar space by second molar mesialization. They found an increase in the buccolingual width of the alveolar ridge as the second molar moved anteriorly, 1–2 mm of mean crestal bone loss mesial to the second molars, and insignificant root resorption. Both studies indicated that orthodontic space closure by second molar protraction in adults was effective and offered a potential solution in the management of missing mandibular first molars. Nonetheless, treatment duration was prolonged in these patients.

The average treatment time for closure of a first molar space ranges from 23 to 52 months in adults.[3] Roberts et al.[19] found that the rate of mandibular molar protraction using endosseous implants as anchorage was 0.33 mm/mo. They reported that the rate of molar mesialization was inversely proportional to the alveolar bone density. At this rate, 10 mm of edentulous first molar space closure will take 2–3 years in adults. Thus, a technique able to increase the efficiency of this orthodontic movement is of primary interest to clinicians. Orthodontic treatment with selective decortication and alveolar augmentation has been proposed[14] as a method with which to enhance the speed of tooth movement. The increased rate of tooth movement has been explained by a regional acceleratory phenomenon, which causes an increase in cortical bone porosity and trabecular bone turnover rate.[20]

However, despite the corticotomy-facilitated procedure, the second molar protraction required 32 months to close 8 mm of space in this patient. This prolonged

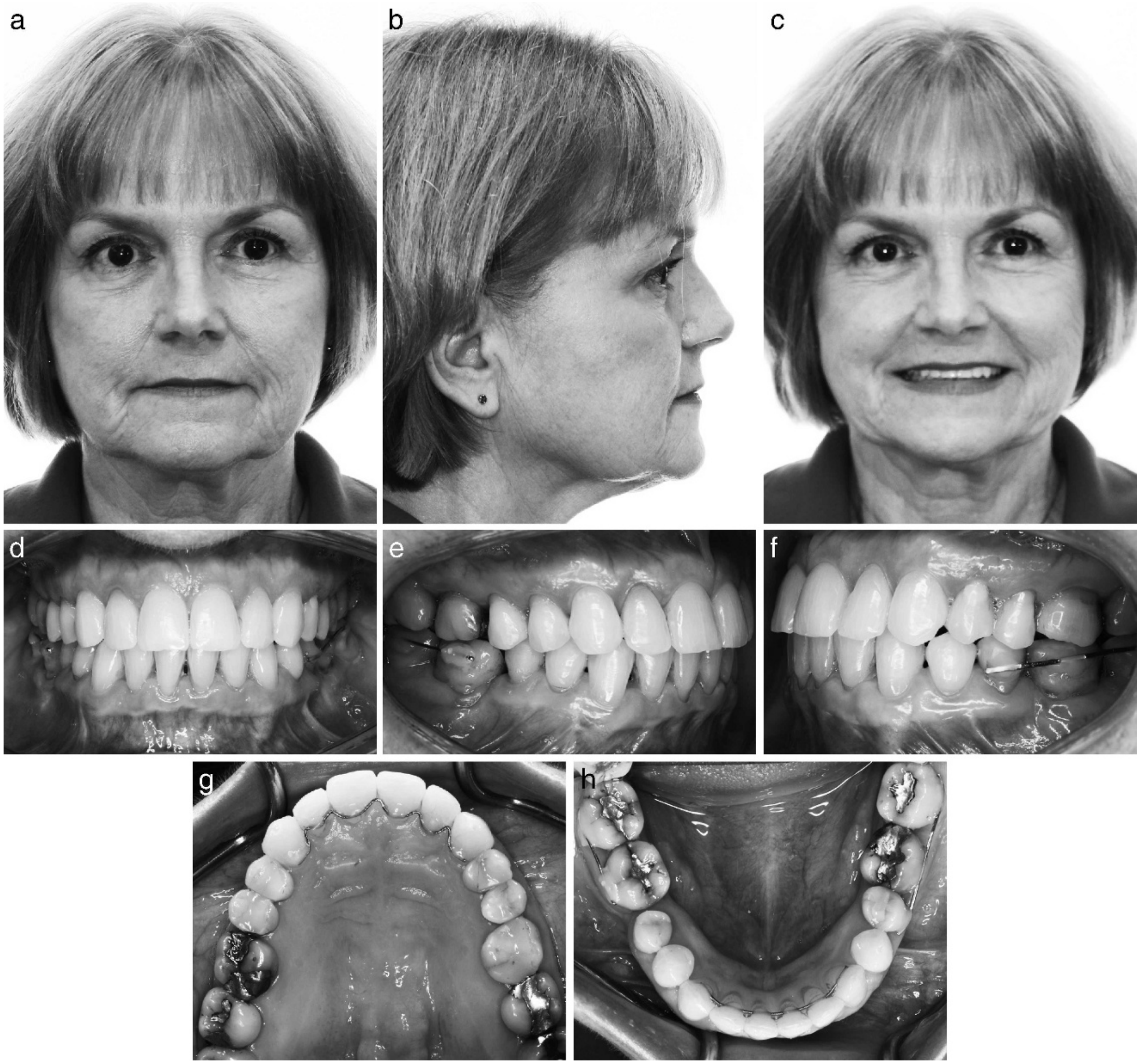

Figure 14. One-year retention photographs.

treatment coincides with the findings of Kim et al.[2] who also found increased treatment time when protracting and uprighting the second molar after performing corticotomies. Factors such as biological response, optimal force levels, frequency of activation, and frequency and extent of surgical insult are some of the confounding variables that need extensive evaluation when analyzing retrospectively the duration of treatment. Among these biologic variables, certain medications, such as cholesterol-lowering drugs, may affect the rate of tooth movement. The patient in this case report was on a daily regimen of 20 mg of Lipitor. No clinical studies have been conducted evaluating the rate of tooth movement in patients taking this type of medication. Animal studies[21,22] have provided conflicting results regarding the anabolic and catabolic effects of statins on bone. Furthermore, no direct study evaluating the rate of tooth movement has been done in animals; therefore, no conclusion can be drawn other than that these drugs may play a role in modulating the rate of tooth movement.

According to Wilcko et al.,[23] decortication alone will not produce a sustainable osseous response to move a tooth mesiodistally. Efficient tooth movement is possible only if a thin layer of bone is present over the root in the direction of tooth movement. Wilcko et al. advocate ostectomy at the extraction site (in premolar extractions) followed by adequate thinning of the bone on the tooth that is being moved. In the patient reported herein, only decortication with bone grafting was done, which could offer a possible reason for the longer treatment time. Since no extraction site was available, no other surgical intervention, such as ostectomy, was possible.

To increase the rate of tooth movement after corticotomy, higher force magnitudes, immediate activation, and frequent reactivation schedules are recommended.[24] If the force adjustments are similar to that of conventional orthodontics, bone healing might occur and tooth movement can be slower. According to Wilcko et al.,[25] activation should be started only 2 weeks after the corticotomy procedure, as this time period will effectively demineralize the thin layer of bone over the root. The resulting soft demineralized bone and tooth can be rapidly moved to the desired position.

After corticotomy, accelerated tooth movement is observed for at least 2–3 weeks,[4,26] and the exaggerated response tapers to normal steady state by 11 weeks after surgery.[27] In humans, a split mouth study[28] found that the enhancement of the speed quickly tapered from the first month to the fourth month when no difference in the rate of space closure in canine retraction between the corticotomy and control sides was reported. To maintain the bone turnover effect, Sanjideh et al.[26] evaluated the rate of tooth movement after one and two corticotomy procedures in foxhounds. After the second corticotomy procedure, increased rate of tooth movement was maintained over a longer period of time. However, the difference in tooth movement between one and two corticotomies was too small to justify a second surgery. Additional costs, time involved, and other factors associated with periodontal surgery contraindicate a second corticotomy procedure. Instead, other, less invasive procedures, such as corticision or low-energy laser stimulation, can provide a cost-effective alternative or adjunct to a corticotomy procedure to maintain the enhanced remodeling effect.

Considering the overall treatment time reduction, additional cost, and health of periodontium after corticotomy, there is little evidence favoring the cost efficiency with this interdisciplinary approach. Moreover, when the limited duration of the corticotomy effect on the rate of tooth movement is considered within the context of a prolonged treatment time observed with molar protraction, this procedure appears to be unjustified.

Based on the evidence, the enhanced rate of tooth movement with corticotomies quickly returns to baseline, and such procedure may be only of some marginal benefit in the alignment and leveling phase of orthodontic treatment.[26] Overall, it may be considered that for space closure, more aggressive bone resective procedures may be needed, as has been reported[29] with dentoalveolar distraction in canine retraction. However, since no extraction space may be modified in molar protraction, this technique may be difficult to apply.

Other, more invasive surgical approaches, such as dentoalveolar distraction,[29] might aid in enhancing the rate of molar protraction. However, the current level of evidence showing reduced treatment duration after corticotomy is limited to case reports. Randomized controlled trials are required to evaluate the short- and long-term effects of corticotomy-based procedures and other types of surgical insults that may provide the greatest impact on the rate of tooth movement.

CONCLUSIONS

- Protraction of the second molars using miniscrews is a viable, cost-effective option for managing missing lower first molars.
- Corticotomy-assisted molar protraction with miniscrew anchorage did not reduce the treatment time for this patient, as the osseous response to localized injury was not sustained for the majority of space closure duration.

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