CASE REPORT

Orthodontic Treatment of an Adult Patient with Severe Crowding and Unilateral Missing Premolars

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Adult patients sometimes present with unilateral missing premolars. If there are arch-length discrepancies, treatment may involve extraction of other premolars followed by space closure. The spaces can be partially closed, leaving room for a single dental implant, or completely closed with orthodontic tooth movement. In the latter case, the result will be an unusual occlusion with a canine contacting a molar.

This report describes an adult female patient with severe crowding and unilateral missing mandibular premolars who was treated by extraction of additional premolars and full orthodontic space closure.

Diagnosis and Treatment Plan

A 35-year-old female presented with the chief complaint of high canines. She reported that her mandibular right first and second premolars had been extracted several years earlier due to dental caries and crowding (Fig. 1). According to Seibert's ridge-defect classification,[1] she was a Class I (buccolingual loss of tissue with normal ridge height in an apicocoronal dimension). The patient displayed severe crowding in the maxillary arch, and would have had severe crowding in the mandibular arch as well if her premolars had not been extracted. She had Class I molar and full Class II canine relationships on the right side and Class I molar and end-on canine relationships on the left, with a 2mm overjet and 40% overbite. The maxillary dental midline was

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Fig. 1 35-year-old female patient with severe crowding, deviated lower midline, and previously extracted mandibular right first and second premolars.

TABLE 1
CEPHALOMETRIC ANALYSIS

	Japanese Norm	Pre-treatment	Post-Treatment	Post-Retention
SNA	82.0°	75.7°	75.4°	75.1°
SNB	80.0°	75.2°	74.7°	74.7°
ANB	2.0°	0.5°	0.7°	0.4°
Wits appraisal	1.1mm	–4.5mm	–2.9mm	–3.2mm
SN-MP	34.0°	37.2°	35.4°	36.1°
FH-MP	28.2°	28.3°	26.5°	27.0°
Lower facial height	55.0%	54.8%	54.6%	54.4%
U1-SN	104.0°	101.9°	103.0°	102.5°
U1-NA	22.0°	26.2°	29.6°	28.9°
IMPA	90.0°	89.3°	89.5°	87.7°
L1-NB	25.0°	21.7°	19.7°	18.5°
U1/L1	124.0°	131.5°	130.0°	132.2°
Upper lip	1.2mm	–1.1mm	–4.3mm	–4.5mm
Lower lip	2.0mm	0.5mm	–1.8mm	–1.8mm

coincident with the facial midline, but the mandibular dental midline was deviated by 2mm to the right.

A panoramic radiograph revealed that the patient was also missing her maxillary third molars. Cephalometric analysis (Table 1) indicated a skeletal Class I (ANB = .5°) with a hyperdivergent growth pattern (SN-MP = 37.2°). The maxillary incisors were slightly retroclined (U1-SN = 101.9°), but the mandibular incisors were normally inclined (IMPA = 89.3°).

One treatment option was to extract the maxillary first premolars and mandibular left second premolar (due to its significant restorations) and close the extraction spaces. The space of the missing mandibular right premolars would be restored with a dental implant after orthodontic treatment. The patient declined this plan because she did not want to have an implant.

Another alternative was to restore the space of the mandibular right premolars by autotransplantation of the maxillary right first premolar. Although the patient was willing to undergo this procedure, involving socket preparation[2] and a bone graft, the prognosis was not favorable due to the atrophic extraction site and the complete development of the maxillary first premolar.

A final option was to close all the extraction spaces, including the area of the missing mandibular right premolars, with orthodontic tooth movement. This would result in an unusual occlusion between the mandibular right canine and first molar, along with a risk of dehiscence on the buccal side of the mandibular right first molar after mesial movement of the tooth. After fully discussing the options with her general dentist, the patient agreed to this treatment plan.

Treatment Progress

Once the maxillary first premolars and mandibular left second premolar were extracted, preadjusted .022" × .028" appliances were bonded in both arches for leveling and alignment. The maxillary arch was leveled with a series of continuous archwires, from .014" nickel titanium to .019" × .025" beta titanium (Fig. 2).

After four months of leveling and alignment, two 1.6mm × 9mm temporary anchorage devices* (TADs) were inserted in the

*OSAS, registered trademark of Dewimed Medizintechnik GmbH, Tuttlingen, Germany; www.dewimed.de.

Fig. 2 After four months of leveling and alignment.

interradicular bone between the maxillary second premolar and first molar. The bone was of sufficient quality that the TADs could be loaded immediately. An .019" × .025" stainless steel archwire was then used for en masse retraction and intrusion of the maxillary anterior teeth.

When the patient declined to have TADs inserted in the mandibular arch, an .017" × .025" stainless steel lower archwire with closing loops was placed, and Class II elastics were used to protract the mandibular molars during space closure (Fig. 3). To help open the bite, chain elastic was attached from the TADs to crimpable archwire hooks between the maxillary central and lateral incisors. The patient also wore midline elastics at night to correct the dental midline.

After 22 months of treatment, the crimpable hooks were moved between the maxillary lateral incisors and canines, and elastics were engaged to the TADs for bodily retraction of the anterior teeth (Fig. 4).

Final detailing was accomplished with .016" × .022" stainless steel archwires in conjunction with posterior up-and-down elastics and midline elastics. Total treatment time was 32 months (Fig. 5A).

Fixed retainers were bonded from maxillary lateral incisor to lateral incisor and from mandibular canine to canine, and wraparound removable retainers were also delivered for both arches. To prevent reopening of the extraction spaces, the mandibular left canine and first premolar, the mandibular right canine and first molar, and the maxillary canines and second premolars were tied together with stainless steel ligatures for six months after debonding.

During orthodontic therapy, the patient required endodontic treatment of her mandibular right third molar. Because the endodontically treated tooth had an extensive secondary carious lesion, the patient was informed that she would need a future autotransplantation of the mandibular left third molar to the right third molar site.[3-7]

Treatment Results

All treatment objectives were achieved, including Class I canine relationships, a Class III molar relationship on the right side, and a Class I molar relationship on the left, with acceptable overbite and overjet. Facial photographs showed an improvement

Fig. 3 After another six months of space closure and anterior intrusion, using skeletal anchorage in maxillary arch and closing loops for molar protraction in mandibular arch.

Fig. 4 After 22 months of treatment, showing bodily retraction of maxillary arch. Closing loops were cinched and engaged with elastic separating rings at mandibular extraction sites to enhance activation and patient comfort.

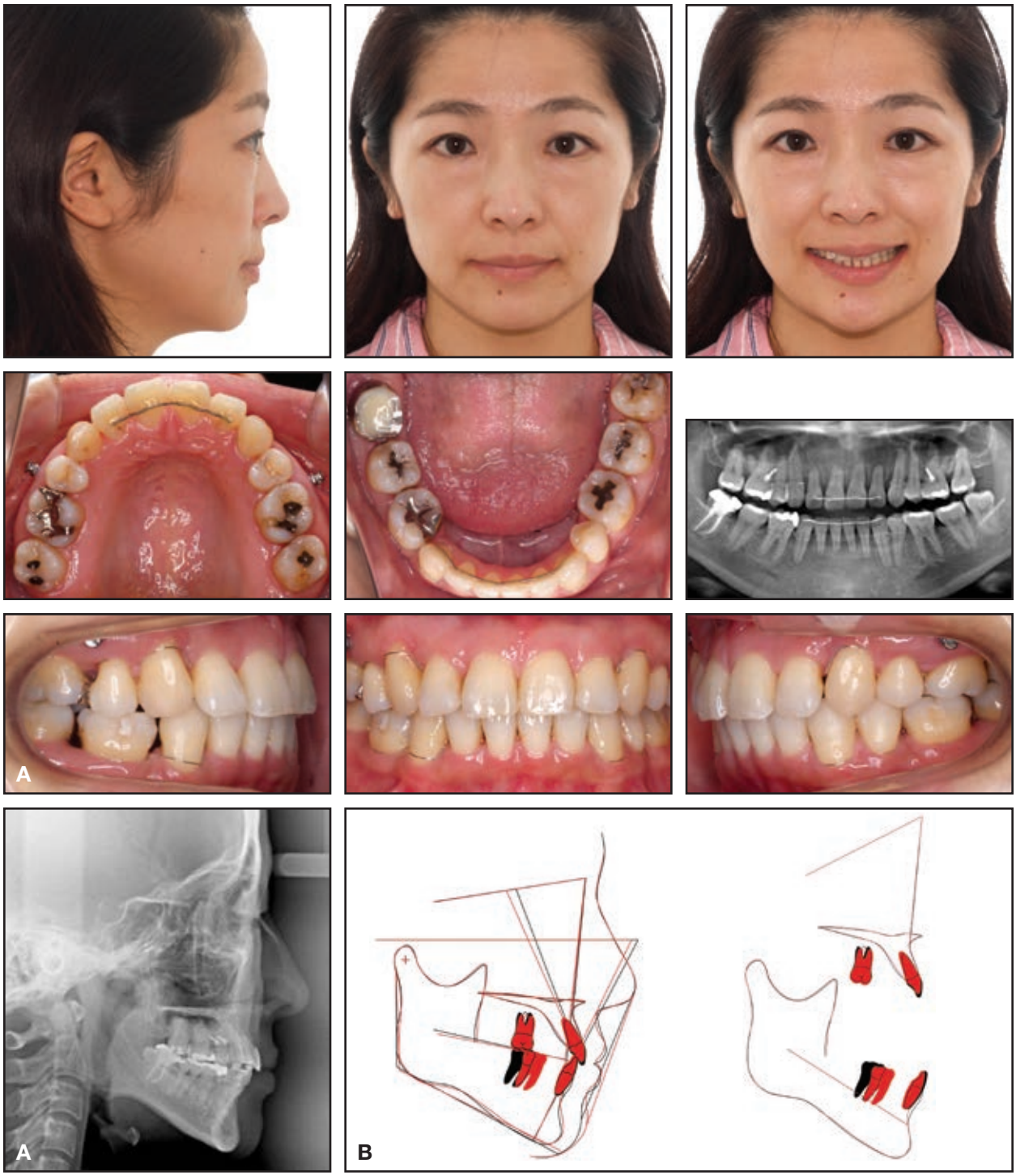

Fig. 5 A. Patient after 32 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

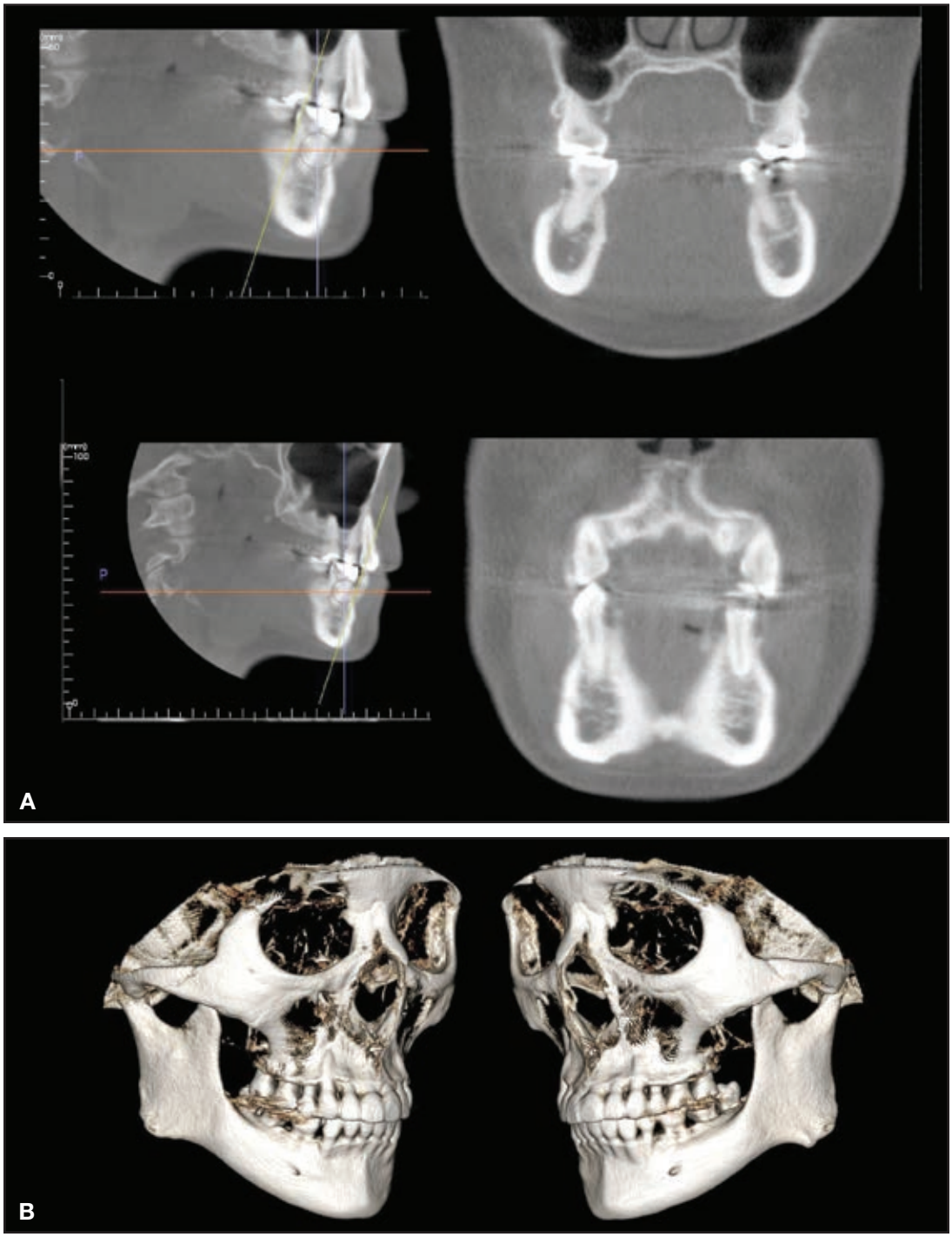

Fig. 6 A. Post-treatment multiplanar reconstruction images indicate dehiscences of mandibular right canine and first molar. B. Volume rendering shows dehiscences are insignificant compared with those of other teeth.

Fig. 7 Patient four years after end of treatment.

in smile esthetics.

A post-treatment panoramic radiograph confirmed the space closure and acceptable root parallelism. There were no significant signs of bone resorption, although the anterior teeth did demonstrate some signs of apical root resorption. The mandibular left third molar was banded during treatment, but it was not moved aggressively to reduce the chance of root resorption, in case the tooth was needed for future autotransplantation to the contralateral third-molar position.

Post-treatment cephalometric analysis and superimposition (Fig. 5B, Table 1) indicated no significant skeletal changes (ANB = .7°; SN-MP = 35.4°). The maxillary incisors were now normally inclined (U1-SN = 103°), and the mandibular incisors were unchanged (IMPA = 89.5°). Cone-beam computed tomography (CBCT) showed dehiscences on the mandibular right canine and first molar, but the amount was insignificant compared to that of the other regions (Fig. 6).[8]

At the four-year follow-up examination, the occlusion was stable, and the treatment results had been maintained (Fig. 7).

Discussion

A combination of severe crowding, bimaxillary dentoalveolar protrusion, and a significant midline discrepancy is difficult to address with orthodontics alone. Premolar extractions must often be combined with orthognathic surgery to correct all dental and facial problems. If a patient declines the surgical option, however, the extraction of two premolars or one premolar and a molar in the same quadrant can create enough space to relieve severe crowding, retract the proclined and protrusive anterior teeth, and correct the midline discrepancy.[9] Such a case can now be treated by removing only one premolar in each quadrant and using temporary skeletal anchorage for en masse distalization.[10,11]

Treatment options for a case with unilateral missing mandibular premolars depend on the patient's age, the developmental stages of the adjacent teeth, and the condition of the atrophic extraction site. Potential risks of molar protraction through an atrophic ridge include dehiscence, mobility, loss of attachment, ankylosis, root resorption, devitalization, and tooth morbidity.[12] Protraction of mandibular molars also causes rotation around the center of rotation of the entire arch, which can open the bite and produce a posterior crossbite.[12,13] Since the mandibular first molar is much larger than the premolar, this movement can compromise the integrity of the mandibular occlusion, increase the likelihood of root dehiscence, and result in severe occlusal wear of the antagonistic maxillary premolar.[14] While successful molar protraction through atrophic ridges has been reported,[15,16] few studies have documented orthodontic closure of two missing premolar sites in the same quadrant. The case shown here indicates that such an approach may be a viable alternative to restoration with dental implants or bridges.

In adult patients, atrophic changes of the alveolar processes must be carefully evaluated before moving teeth into unilateral missing premolar spaces. Tallgren found that the mean reduction in mandibular anterior alveolar ridge height after extractions was about four times the reduction in the maxillary anterior alveolar ridge.[17] Carlsson and Persson also reported a decrease in mandibular anterior alveolar ridge height after the extraction of entire dentitions for denture replacement.[18] Tallgren and colleagues found vertical resorption of the maxillary anterior ridge to be twice that of the posterior region during the first year after extractions.[19] According to these studies, 60-65% of the vertical resorption will occur in the first year after tooth extraction.

Ostler and Kokich showed that in cases with congenitally missing mandibular second permanent molars, the alveolar ridge width declined by about 25% over the three-year period following extraction of the second deciduous molars.[20] The ridge-resorption rate then diminished over the next four years, with an additional 4% of alveolar ridge loss. The final ridge width was only slightly less than the width of the first premolar. These authors concluded that the reduction in alveolar ridge width was not correlated with the time after extraction, but that the age of the patient at the time of extraction had a weak association with the change

in alveolar ridge width.

When moving a tooth through an atrophic extraction site, the potential for developing dehiscences and fenestrations must be carefully evaluated. Davies and colleagues defined dehiscence as a lack of cortical bone at the level of a dental root, at least 4mm apical to the interproximal bone margin; fenestration is a localized defect in the alveolar bone that exposes the root surface, usually the apical or middle third, without involving the alveolar margin.[21] Dehiscences are most commonly associated with the mandibular canines and first premolars and the maxillary canines and first molars, while fenestrations are most often found on the maxillary first molars, second molars, and canines and the mandibular canines and lateral incisors.[21,22] The risk of post-extraction resorption is significantly greater on the buccal than on the lingual side in both arches.[23] Fenestrations and dehiscences cannot be evaluated with conventional radiographs; in our patient, CBCT was required to identify dehiscences of the mandibular right canine and first molar, which were insignificant compared to those in other regions.

Overall, our patient was quite satisfied with her treatment. She did not require any restorations with dental implants, and her results were stable after four years of retention.

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