C. M. Coelho Filho[1]

Fabio O. Coelho[2]

Larry W. White, DDS, MSD[3]

CLOSING MANDIBULAR FIRST MOLAR SPACES IN ADULTS

Adult orthodontic patients with missing mandibular first molars and large spaces to close have challenged orthodontists for many decades. Most of the techniques previously used to close such spaces have rendered equivocal results that typically result in compromised treatment. The mandibular protraction appliance offers orthodontic clinicians a method to close those spaces by bringing the mandibular second molars forward without retracting the mandibular incisors. This presents a method for managing large mandibular spaces without resorting to prosthetic replacements. World J Orthod 2006;7: 45–58.

Adult orthodontic patients with absent or severely compromised mandibular first molars pose critical problems for orthodontic clinicians. When these patients also have mandibular arch length discrepancies and/or incisor protrusions, the treatment plans must consider the possibility of extracting the damaged teeth, since the removal of healthy premolars holds little appeal for doctors or their patients. Nevertheless, several caveats must temper any decision to extract mandibular first molars:

1. Most orthodontists understand the mechanical difficulties of moving mandibular second molars into first molar positions. In many cases the mandibular incisors tip lingually maximally, while the second molars move minimally.
2. Class II malocclusions exaggerate the above problem since so few sources for providing mandibular incisor anchorage have been available.
3. Alveolar osseous loss frequently occurs when mandibular first molars are absent. This lack of bone complicates the mesial movement of the second molars and also makes the placement of implants and/or prosthetic replacements difficult.

LITERATURE REVIEW

Graber[1] has stated that clinicians can seldom close molar spaces with limited orthodontic therapy. The large root surfaces of molars make their movement uncertain while simultaneously causing unwanted tooth movements elsewhere. Graber has suggested that such patients may profit most from simply uprighting the second molars and providing subsequent prostheses.

Kessler[2] has suggested not moving mandibular second molars mesially because their roots have wider dimensions than the adjacent edentulous ridge and could possibly cause a loss of osseous support. In addition, any periodontal osseous defect could widen if the molar tips distally and necessitate an osseous graft.

[1]Private practice of Orthodontics. Sao Luis, MA, Brazil.
[2]Graduate Student, Department of Orthodontics, Uniararas University, São Paulo, Brazil.
[3]Private practice of Orthodontics. Dallas, Texas, USA.

CORRESPONDENCE
Dr Coelho Filho
Rua Prof. Luis Pinho Rodrigues 20, sala 204
Renascenca II
Sao Luis, Maranhao, 65075-740, Brazil
E-mail: carlosm@elo.com.br

In contrast, Brown[3] showed that uprighting of molars produced significant reduction in the depth of existing periodontal defects and highly favorable changes in the gingival architecture. The gingival margin moved from a coronal position approaching the marginal ridge to a more inferior location adjacent to the cementum of the anatomic root. This increased the length of the clinical crown with a concurrent decrease in the depth of the periodontal pocket. Even though Brown also discovered that the alveolar bone level decreased between 0.5 and 1.0 mm along with the pocket depth reduction, he considered it therapeutically insignificant. Hom and Turley[4] studied the dental and periodontal changes that occur when mandibular second molars move into first molar positions. They selected 14 adult patients treated in private clinics and examined the pre- and posttreatment orthodontic records, including study casts, cephalometric tracings, and panoramic and/or periapical radiographs. Every individual displayed significant space closure ranging from 2.7 to 11.5 mm. A small amount of crestal bone loss occurred mesial to the second molars in all but 5 patients, but these 5 patients displayed osseous accumulation at that position. These patients averaged an increase in alveolar ridge width of 1.2 mm. The Hom and Turley study indicated that mandibular space closure was not only possible, but that it could provide great benefits for some patients. They proposed space closure as a potential therapy for the absence of mandibular first molars.

Ingber[5] showed that forced eruption can correct isolated 1- or 2-wall infrabony osseous defects. Extrusion of a tooth from its alveolus causes a stretching of the gingival and periodontal ligament fibers. This results in a coronal shift of the bone at the base of the defect as the tooth moves occlusally. These vertical osseous defects frequently occur with an inclined alveolar crest on the mesial side of the second molar.

Roberts et al[6] noted that if the relationship between the alveolar crest and the cementoenamel junction is constant during molar uprighting, the angular osseous crest mesial to the tipped molar is not only eliminated but also somewhat reversed in inclination. Moreover, if extrusive forces are used to correct the vertical osseous defects, they should follow the correction of molar inclination to allow better control of the rapid molar extrusion and the periodontal inflammation.

Stepovitch[7] studied the changes in the edentulous ridge and adjacent teeth before and after closure of mandibular first molar spaces. The first molar areas had no evidence of the residual socket. The sample consisted of 8 adolescents and 8 adults who had completed orthodontic treatment. Stepovitch found that clinicians can change the buccolingual width of the alveolar ridge through orthodontic treatment. The alveolar bone readily followed the teeth into the edentulous spaces in the teenagers. Nevertheless, half of the adult patients resisted the formation of any bone during space closure. The other half of the adult population developed only minimal amounts of new bone. Both groups showed a loss of crestal bone mesial to the second molars. No root resorption occurred in the adolescent group and only 2 adults displayed any root resorption. The author concluded that clinicians can close first molar spaces of 10 mm or more in adults and juveniles, but maintaining closed spaces in adult patients remained difficult.

Daugaard-Jensen[8] writes that after more than 15 years of experience of extracting first permanent molars, she can provide clinical evidence that restrictions on the extraction of these teeth are invalid. Daugaard-Jensen has written that so many advantages accrue with first molar extractions that they might provide the procedure of choice in a number of patients with arch length discrepancy. Many times the removal of premolars will not supply enough space for normal alignment, nor will the extraction of third molars solve the space problem. Dissatisfaction with postretention relapse of the mandibular incisors in apparently well-treated first premolar extraction patients caused Daugaard-Jensen to extract first molars instead of first premolars. She made this decision after noticing that mandibular incisor crowding did not recur

in patients who had first molars extracted because of extensive caries. The author gained so much satisfaction from these cases that she now has no hesitation to extract 4 first molars, even when they have good shape and form, if the arch length discrepancy and protrusion is so severe as to suggest the removal of 8 teeth, ie, 4 first premolars and 4 third molars.

USE OF THE MANDIBULAR PROTRACTION APPLIANCE

Although the rationale for extracting first molars when the arch length discrepancy and protrusion greatly exceed normal is understood, the present authors limit the extraction of these teeth unless they have compromised futures due to severe caries, unsuccessful root canal therapy, or other serious limitations. In such cases, all first molars are ordinarily extracted, even when only one of them is seriously threatened. By doing so, clinicians can apply simple and symmetric mechanics. Such a decision requires an analysis of the third molars to assess their size, morphology, and root development.

Mechanics associated with the mandibular protraction appliance (MPA)[9,10] are used by the authors. The MPA is seen in Fig 1.

After using part of the mandibular first molar spaces to diminish the arch length discrepancy and/or reduce the mandibular incisor protrusion, the anterior teeth are anchored with a MPA, and a closing archwire with activated bull loops is employed to bring the mandibular second molars forward. The third molars ordinarily follow the second molars in their forward movement. Simultaneously, sliding mechanics are used to retract the maxillary incisors if an overjet occurred because of mandibular incisor alignment and retraction. At this point the mandibular second molars will have moved forward, and the maxillary molars will have a Class III occlusion. The authors now discontinue the MPA and place light tip-back bends just distal to the maxillary second premolars and begin to bring the maxillary second molars forward into a Class I arrangement with elastomeric chains.

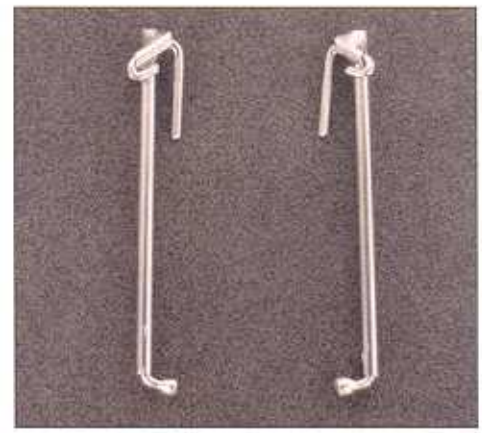


Fig 1 The mandibular protraction appliance (MPA).

These simple mechanics work efficiently and consistently give good results. In this article, the case records of 2 adult patients are presented; in each, the mandibular first molars were absent and the maxillary first molars were also missing or extracted to keep the arches coordinated and symmetric.

PATIENT 1

This female patient, 28 years of age, had a Class I bimaxillary protrusion and open bite. She was compromised by the absence of the maxillary right first molar and large restorations on the maxillary right and left first molars.

Treatment plan

Treatment consisted of 2 phases; in phase 1, when the patient was 16 years of age, the maxillary right and left first molars as well as the mandibular left first molar were extracted because of bimaxillary protrusion associated with the open bite. Closing of the extraction spaces would serve to reduce the bimaxillary protrusion and simultaneously close the bite. The pretreatment records are shown in Figs 2 to 5.

PATIENT 1: PRETREATMENT

Fig 2 Pretreatment facial views. The patient was 16 years of age.

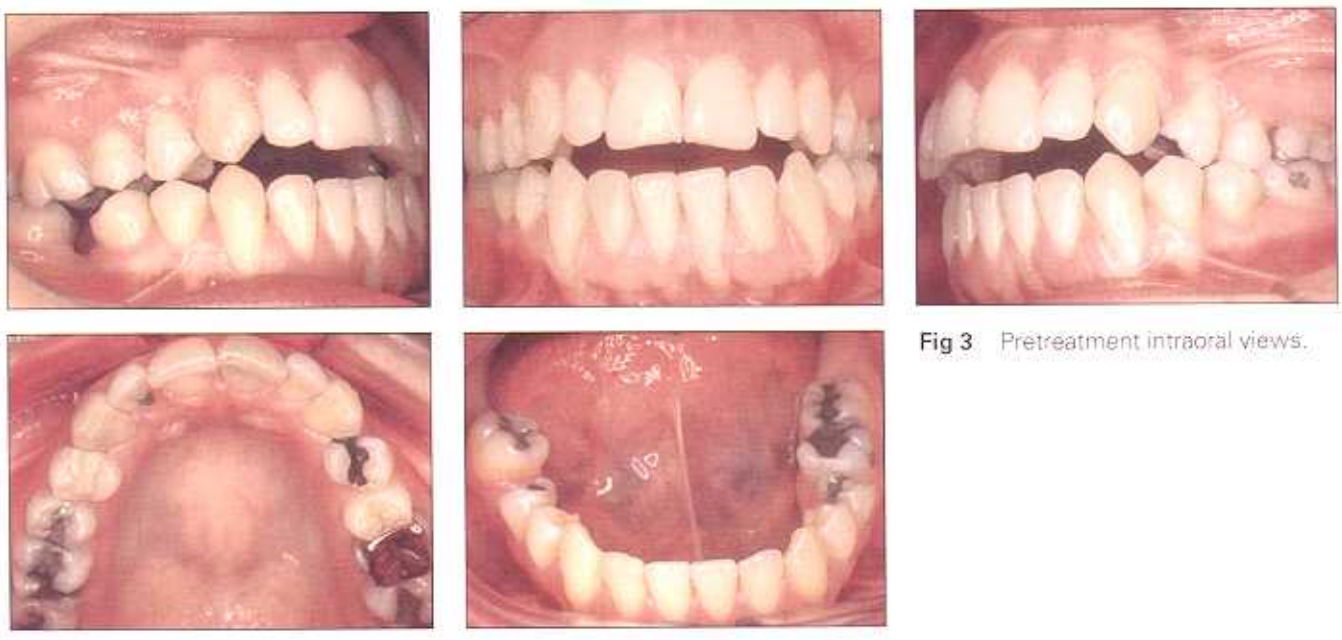


Fig 3 Pretreatment intraoral views.

Before space closure concluded, the patient terminated treatment and returned 9 years later, at 28 years of age. Upon her return, the spaces that had not closed previously were still present. The teeth were in a Class II relationship, and there was a slight mandibular midline shift to the left. Figures 6 to 9 show the patient's condition when she resumed treatment.

Spaces were closed with sliding mechanics after molar uprighting (Figs 10 and 11). Midline correction and a Class I relationship with a unilateral left MPA were achieved. The mandibular right second molar was brought forward by a bull loop

Fig 4 Maxillary left and right first molars and the mandibular left first molar were extracted.

Fig 5 Pretreatment cephalometric radiograph.

and the third molar space was scheduled to have a metallic implant to serve as antagonist to the maxillary right third molar. Treatment was interrupted again for several months because the patient had to undergo medical surgery. Posttreatment records are shown in Figs 12 to 15.

Cephalometric data revealed expectations for an adult patient, with few deleterious effects from treatment (Fig 16, Table 1). The palatal plane rotated downward and backward with a concomitant intrusion of the maxillary occlusal plane. The mandible rotated forward, which helped close the anterior open bite.

PATIENT 1: 28 YEARS OF AGE

Fig 6 Facial views when the patient returned 9 years later to resume treatment. The patient was 28 years of age.

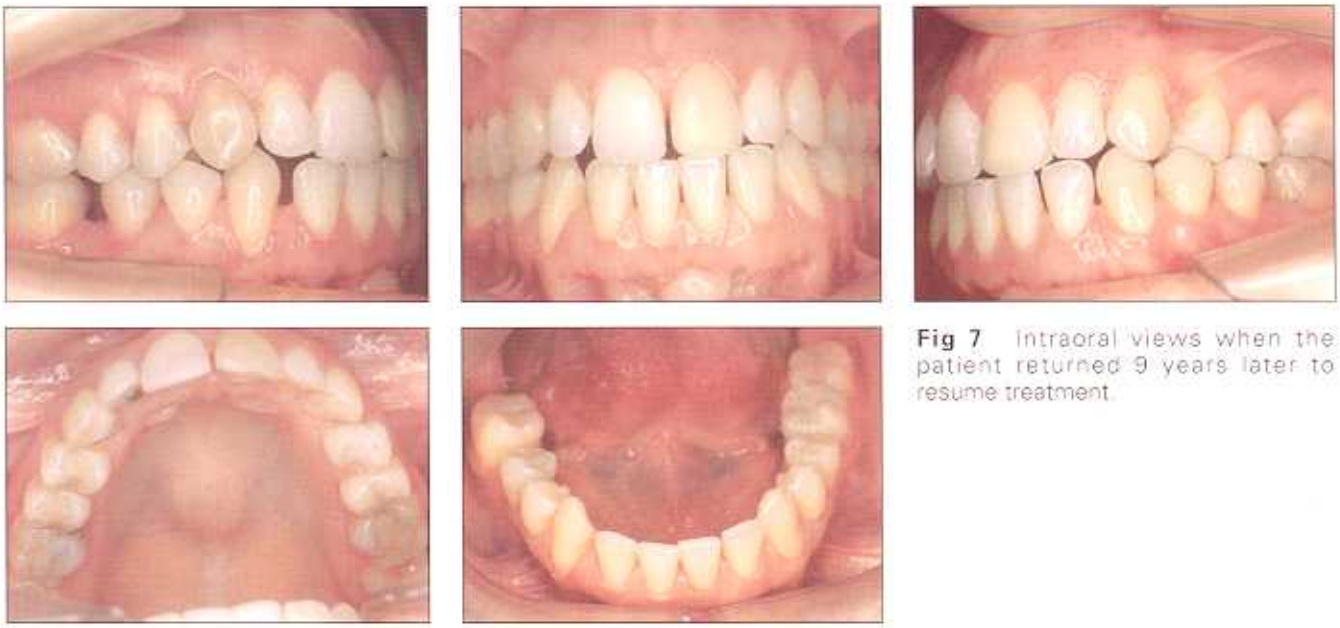


Fig 7 Intraoral views when the patient returned 9 years later to resume treatment.

Fig 8 *(left)* Cephalometric radiograph taken when the patient resumed treatment 9 years later.
Fig 9 *(above)* Panoramic radiograph taken 9 years after treatment interruption.

PATIENT 1: TREATMENT

Fig 10 Facial views during space closure with the MPA.

Fig 11 Unilateral MPA in place to correct midline and assist in anchorage during space closure.

PATIENT 1: POSTTREATMENT

Fig 12 Posttreatment facial views.

PATIENT 1: POSTTREATMENT *CONTINUED*

Fig 13 Posttreatment intraoral views.

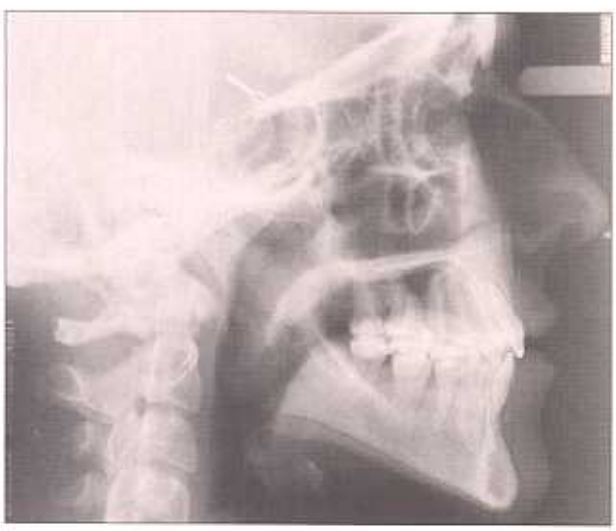
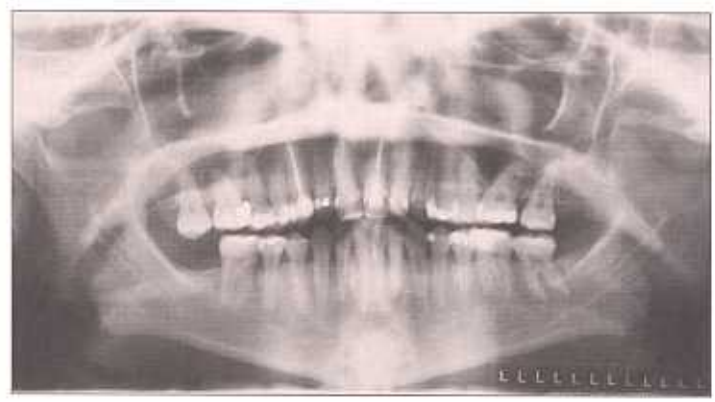


Fig 14 *(left)* Final cephalometric radiograph.
Fig 15 *(below)* Final panoramic radiograph.



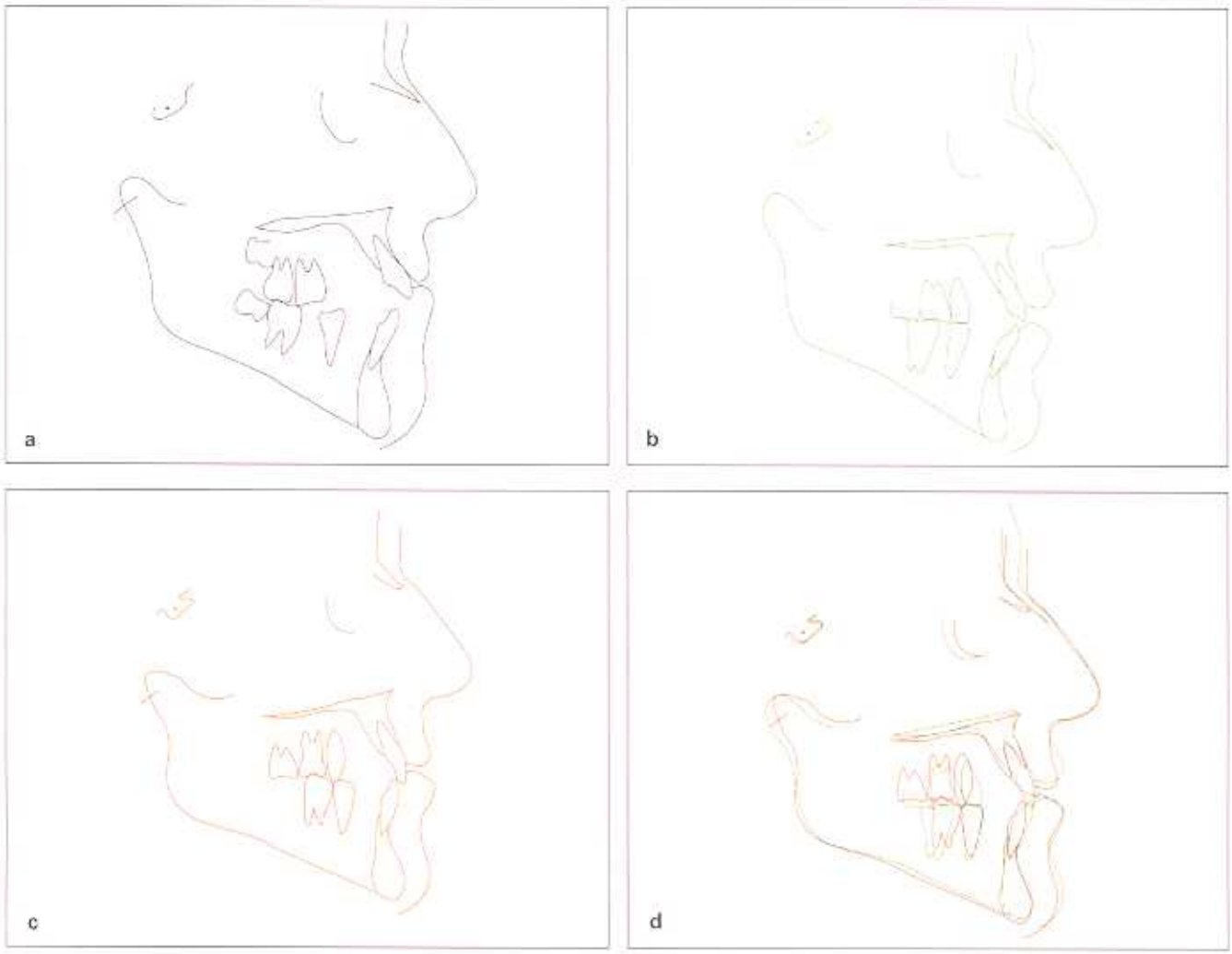


Fig 16 Patient 1. Cephalometric tracings. **(a)** Initial (first stage). **(b)** Return to treatment. **(c)** Final. **(d)** Superimposition.

Table 1 Cephalometric data for patient 1

	Initial	9 years later	Final
S-N (mm)	75	80	80
S-Ar (mm)	37	40	40
Ar-Go (mm)	44	45	45
Go-Gn (mm)	82.5	90	92
Y-axis (mm)	138	140	141
Wits (mm)	−1.5	−0.5	−0.5
1-NB/Pg-NB (mm)	5:4	5:5	5:6
SNA (degrees)	80	79	80
SNB (degrees)	78	78	79
ANB (degrees)	2	1	1
1-SN (degrees)	108	104	100
S (degrees)	126	125	122
Ar (degrees)	138	125	122
Go (degrees)	135	132	132

PATIENT 2: PRETREATMENT

Fig 17 Pretreatment facial views, at 28 years of age.

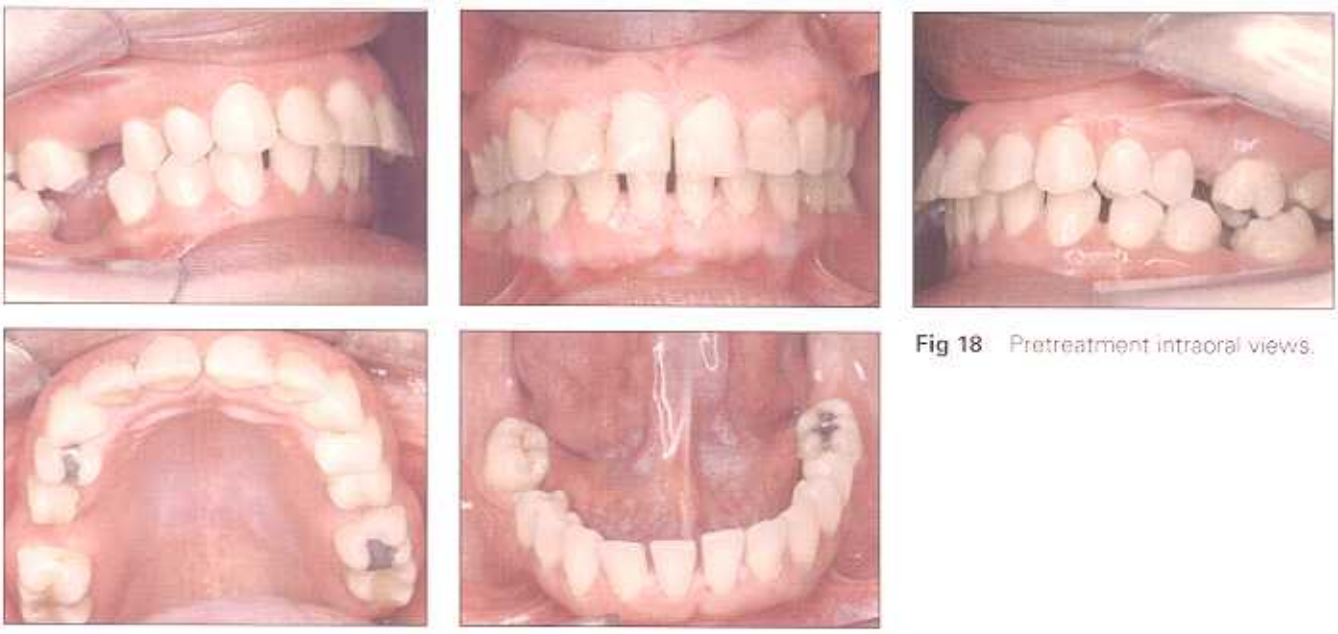


Fig 18 Pretreatment intraoral views.

PATIENT 2

This female patient, 28 years of age, had a Class II Division 1 malocclusion, with an absence of all first molars and mandibular third molars (Figs 17 to 20).

Treatment plan

Closure of mandibular spaces by bringing the mandibular third molars forward with mandibular anterior anchorage was provided by a MPA, which concomitantly secured the maxillary second molar anchorage used to retract the anterior teeth. The absent mandibular third molar spaces will have implants after

Fig 19 *(below)* Initial panoramic radiograph.
Fig 20 *(right)* Initial cephalometric radiograph.

PATIENT 2: MPA IN PLACE

Fig 21 Facial views with the MPA in place.

Fig 22 Intraoral views with the MPA in place.

PATIENT 2: POSTTREATMENT

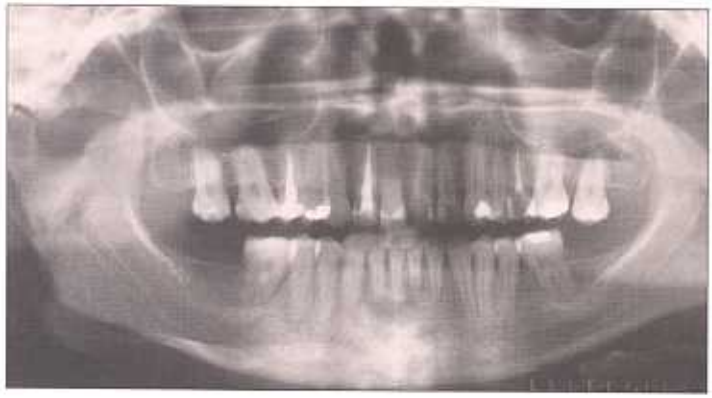
Fig 23 Posttreatment facial views.

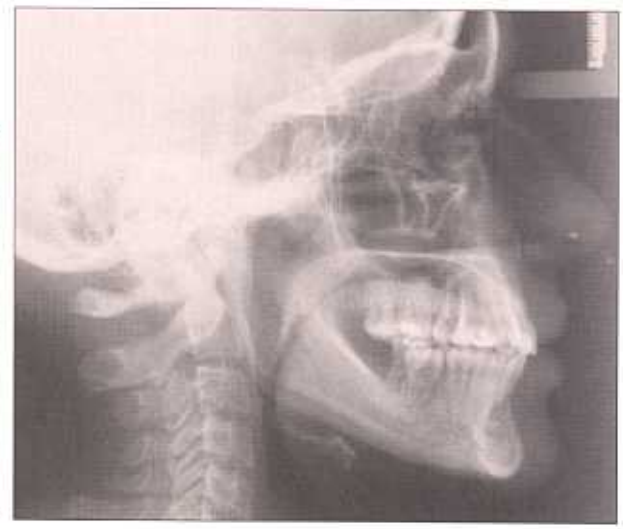
Fig 24 Posttreatment intraoral views.

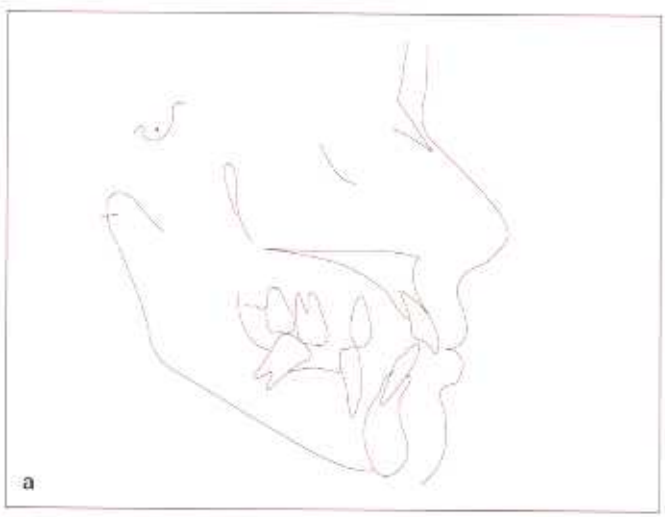
orthodontic treatment, to serve as antagonists to the maxillary second molars. The patient preferred third molar implants rather than other options presented. Treatment time was 34 months. Treatment and posttreatment records are shown in Figs 21 to 26. Cephalometric tracings and superimpositions are shown in Fig 27; cephalometric data are shown in Table 2.

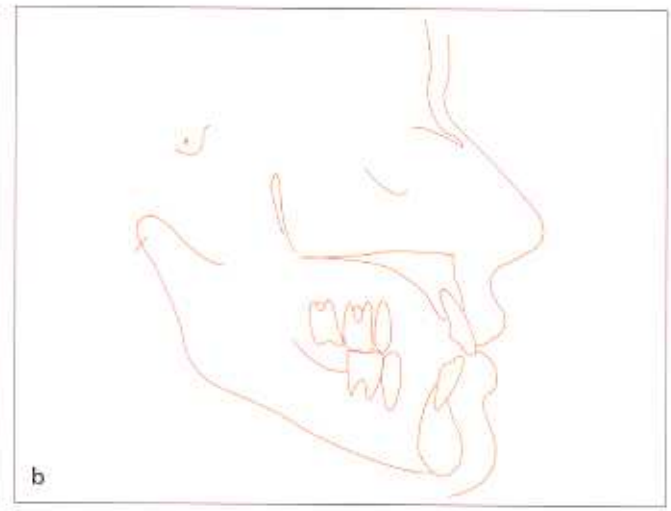
Posttreatment, the labial inclination of the maxillary incisors to S-N reduced from 112.5 degrees to 105 degrees. SNB increased from 81.5 degrees to 87 degrees, while SNA increased from 86 degrees to 88.5 degrees. These dentoalveolar alterations likely helped to correct the maxillomandibular Class II relationship. As with patient 1, scheduled implants placed distal to mandibular second molars will act as antagonists to the maxillary second molars.

Fig 25 *(right)* Final cephalometric radiograph.
Fig 26 *(below)* Final panoramic radiograph.









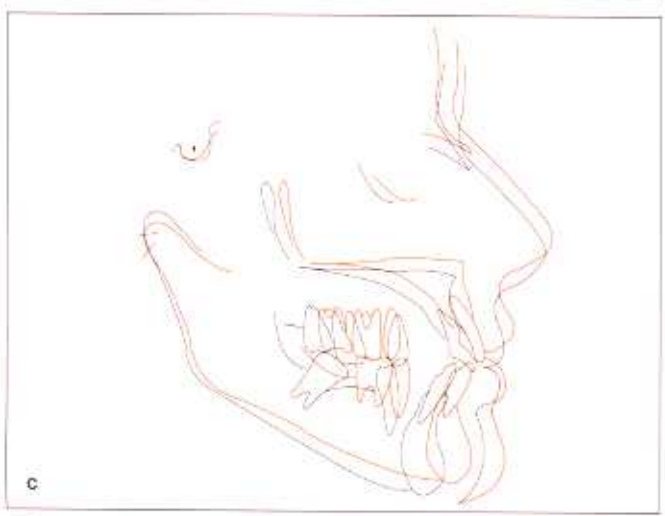


Fig 27 Cephalometric tracings. **(a)** Initial. **(b)** Final. **(c)** Superimposition.

Table 2 Cephalometric data for patient 2

	Initial	Final
S-N (mm)	80	80
S-Ar (mm)	33	33
Ar-Go (mm)	51	51
Go-Gn (mm)	87	87
Y-axis (mm)	136	137
Wits (mm)	0.5	0.5
SNA (degrees)	86	90
SNB (degrees)	82	85
ANB (degrees)	4	5
1-SN (degrees)	112.5	105
S (degrees)	130	130
Ar (degrees)	130.5	130
Go (degrees)	136	136

RETENTION

These two patients have scheduled implants to replace their mandibular second molars. In the meantime, maxillary Essix retainers will prevent any extrusion of the molars.

RATIONALE OF THERAPIES

Many clinicians might question bringing the mandibular molars forward rather than uprighting them and filling the spaces with implants or ordinary fixed partial dentures. These decisions developed for the following reasons:

Both patients needed incisor retrusion, which would result in molar spaces too small to accommodate proper-sized implants or fixed partial dentures.

The time spent by patients between the conclusion of therapy and the decision to place the implants generally is too long, and patients often decline because of the cost. When patients with uprighted molars and spaces mesial to them choose not to use their retainers, the molars will again tip forward. By bringing the molars forward, clinicians can mitigate any decision by the patient not to use retention or have implants. Should the terminal molar without an antagonist extrude, it can be removed without compromising oral function.

Opening the mandibular molar spaces and closing them with a fixed prosthesis does not appeal to many patients because of partial destruction of the abutment teeth.

When patients have longstanding edentulous spaces, the vertical dimension of the alveolar ridges at the sites seriously diminish, which may limit implant placement.

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