MIH-Related Loss of Mandibular First Molars Resulted in an Acquired Class II Skeletal Malocclusion: Conservatively Treated with Space Closure on One Side and Implant-Supported Prosthesis on the Other

Abstract

***Diagnosis**: A 34-year-old female presented with a Class II partially edentulous malocclusion with 4mm of overjet. Cephalometrics revealed a protrusive maxilla with relative mandibular retrusion (SNA 85°, SNB 78°, ANB of 7°). A slightly retrusive lower lip was associated with missing mandibular first molars, mesially tipped second molars, anterior spacing, and abfraction on the buccal surfaces of the lower premolars. This developmental (acquired) malocclusion is typical for bilateral Molar-Incisor Hypoplasia (MIH).*

***Etiology**: The isolated loss of the first molars in an otherwise healthy dentition is pathognomonic of MIH, usually due to high fever at <3 yr of age. This common childhood problem may result in developmental enamel defects, that render the first permanent molars (6s) highly susceptible to caries soon after eruption. During the late mixed dentition, a bilateral lack of posterior centric stops in occlusion results in a typical pattern of occlusal collapse: mesially tipped second molars, deep curve of Spee, mandibular retrusion, and incisal compensation (increased overjet and/or deep bite).*

***Treatment**: Full-fixed non-extraction treatment was indicated to close the lower right (LR) space, but the lower left (LL) space required preparation for an implant-supported prosthesis because of the missing left third molar. The mesially tipped mandibular molars were uprighted with a copper-nickel-titanium archwire (CuNiTi), open coil springs, and a more gingival orientation of the second molar tubes on the mesial side. During LR space closure, the midline was maintained with an asymmetric Class II elastic in a L-configuration; the elastic coursed from the upper right canine (UR3), passed gingival to the hook on the LR second premolar (LR5) and extended to the LR second molar (LR7). Symmetrical Class II elastics in the same configuration were used bilaterally to resolve the Class II relationship after the LR space was closed. At 17 months of active treatment, an implant was placed to restore the LL6. Following a 6 month healing phase, the implant was uncovered and a healing abutment was placed. To prevent relapse, fixed appliances were not removed until the temporary prosthesis was placed. The final crown was delivered at 23 months.*

***Results**: This difficult malocclusion was treated to an appropriate preprosthetic result in 17 months, and final finishing was achieved after the implant was placed. The cephalometric film documented asymmetric sagittal positions of the TMJs, but transcranial radiographs of the joints in the open and closed positions were within normal limits (WNL). Overall, interdisciplinary treatment for this complex problem with a Discrepancy Index score of 24, was treated to a Cast-Radiograph Evaluation score of 19 and a Pink & White Esthetic Score of 3 in 23 months. At two-year follow-up, occlusal contacts were optimal, the Class I correction was stable, and the profile had continued to improve. All morphology and function was WNL.*

***Conclusions**: MIH can result in challenging symmetric or asymmetric malocclusions that have good potential for conservative skeletal correction. Defining the etiology is an important diagnostic procedure because MIH-related functional retrusion responds well to bite turbos and Class II elastics with an L-configuration. There was no need for functional orthopedics, extractions, temporary anchorage devices, or surgery. (Int J Orthod Implantol 2017;47:26-48)*

Key words:

Molar-Incisor Hypoplasia (MIH), missing first molar, mesially tipped molar, molar uprighting, implant site preparation, asymmetrical mechanics, space management, implant-supported prosthesis

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Introduction

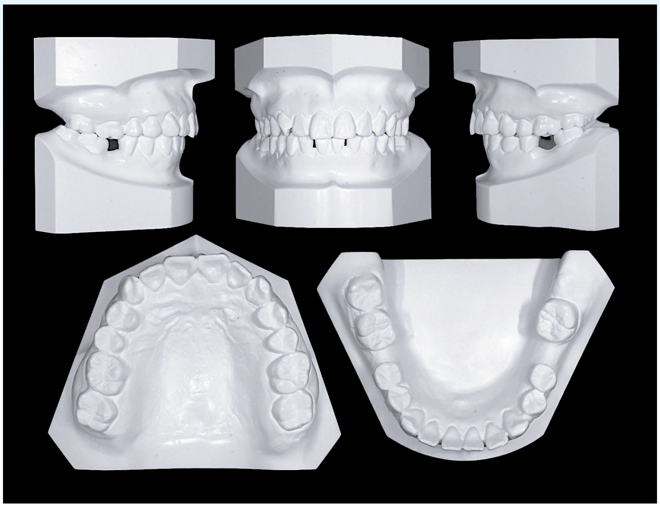
The early loss of permanent 1st molars particularly in the lower arch is associated with a variety of acquired malocclusions that occur after the deciduous second molars exfoliate. Generalized oral hygiene negligence may lead to rampant caries of deciduous and permanent teeth, but the isolated loss of permanent 1st molars is usually related to molar-incisor hypomineralization (*MIH*), a worldwide developmental problem with a prevalence of 10-22%.[1,2] The enamel of the 1st molars develops when children are younger than 3 years of age. Young children commonly spike high fevers up to 104° F (*40° C*) for relatively short periods of time and recover with no apparent problems until the permanent first molars erupt. Elevated fever at <3 years of age may have a deleterious effect on the enamel formation of the first permanent teeth to form: central incisors

■ *Fig. 1: Pre-treatment facial and intraoral photographs* and 1st molars.[1-6] An affected incisor is easily noticed by the parents, but molar hypomineralization is not usually recognized until the child develops a tooth ache after the tooth is destroyed with caries. The "*bombed-out*" first molars are usually extracted at about age 7-9 years. Typically there are no functional problems with occlusion until the 2nd deciduous molars exfoliate. In the absence of posterior centric stops during the late transitional stage of occlusal development (*age 10-12yr*), occlusal collapse and severe acquired malocclusions may occur.[1-4,6]

When a mandibular 1st molar is extracted early, the 2nd and 3rd molars drift mesially into the extraction space. Gingival tissue on the mesial of the second molar may form a plaque-harboring pseudo-pocket that is almost impossible to clean with routine hygiene measures.[7] The objectives of the molar uprighting include: (*1*) eliminate the pseudo-pocket and any associated osseous defects, (*2*) align roots perpendicular to the occlusal plane so that they can optimally withstand the force of occlusion, (*3*) alleviate occlusal trauma, (*4*) correct an excessive curve of Spee, (*5*) improve the crown/root ratios of periodontally involved molars, and (*6*) simplify restorative procedures.[8,9]

Diagnosis and Etiology

A 34yr 6mo female sought orthodontic evaluation with concerns about missing posterior teeth and lower anterior spacing (*Fig. 1*). She had maxillary protrusion (*SNA 85°*) and mandibular retrusion (*SNB 78°*), which resulted in a substantial skeletal discrepancy (*ANB 7°*). There was a slightly retrusive lower lip that was associated with ~5mm Class II occlusion at the canines, 4mm overjet, decreased



■ *Fig. 2: Pre-treatment dental models (casts)*

■ *Fig. 3:*
Frontal view of the mandibular dentition shows anterior spacing.

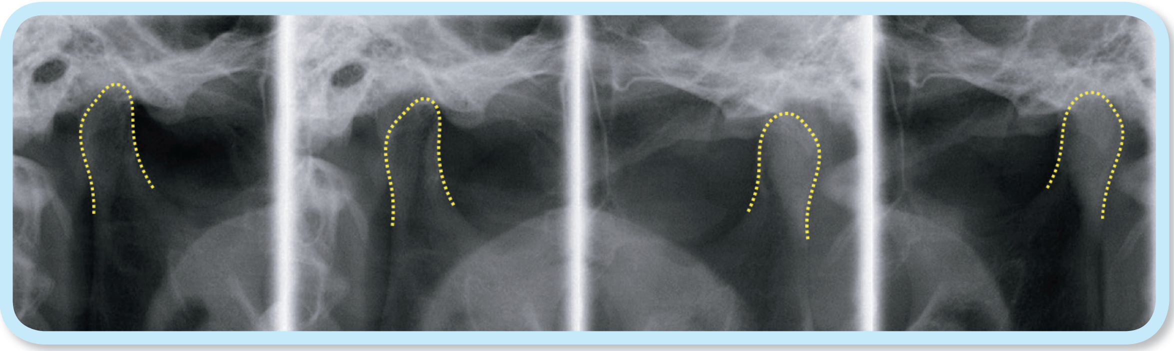
■ *Fig. 4:*
Inferior (left) and lateral (right) views of the incisors show the 4mm overjet and 4mm overbite.

axial inclination of the maxillary incisors, 3mm maxillary anterior crowding, and 2-3mm of anterior spacing in the lower anterior segment (*Figs. 2-4*). Non-carious cervical lesions due to functional overload and/or improper brushing were noted on the premolars. In addition, the overbite and overjet were both 4mm (*Figs. 4 and 5*). The upper dental and facial midlines were coincident, but the lower dental midline was 1mm to the right (*Figs. 1 and 4*).

For this case report quadrants will be designated upper right (*UR*), upper left (*UL*), lower right (*LR*), and lower left (*LL*), and teeth in each quadrant are numbered 1-8 relative to the midline. The pre-treatment panoramic radiograph showed both lower first molars (*LR6 and LL6*) were missing, second molars (*LR7 and LL7*) were tipped mesially into the atrophic spaces, and the only third molar present was in the LR quadrant (*Fig. 6*). Cephalometric radiography (*Fig. 5*) revealed a relatively symmetric mandible, but transcranial views of the temporomandibular joints (*TMJs*) showed the right condyle inferiorly positioned in the fossa when the mandible was closed (*Fig. 7*).

■ *Fig. 5: Pre-treatment lateral cephalometric radiograph*

■ *Fig. 6: Pre-treatment panoramic radiograph*



■ *Fig. 7:*
Pre-treatment transcranial radiographs show closed and open views for the left and right TMJs on the left and right sides of the figure, respectively.

The etiology of the complex malocclusion was diagnosed as MIH, resulting in unrestorable caries and the extraction of the mandibular permanent 1st molars in childhood, prior to age 10 yrs. Cervical ditching was noted on all lower premolars, consistent with abfraction[10] due to heavy occlusal loading. The American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) was 20 points[11] with 4 points added for a compromised implant site for a total DI of 24 points, as shown in the subsequent worksheet 1.

Treatment Objectives

1. **Cervical Ditching on Lower Premolars**: Align the lower arch to distribute the occlusal load over the entire dentition and emphasize proper brushing technique.

2. **Maxilla and Mandible**: Maintain all skeletal relationships.

3. **Maxillary Dentition**: Increase the axial inclination of the incisors, and flatten the curve of Spee to help correct crowding, overjet and overbite.

4. **Mandibular Dentition**: Close LR6 space, prepare LL6 space for an implant-supported prosthesis (*crown*), increase the axial inclination of the lower incisors, and move the entire lower denture mesially to close space, resolve the overjet, and correct the Class II occlusion.

5. **Facial Esthetics:** Correct the retrusive lower lip.

Treatment Alternatives

Option 1. Extract of the LR8, upright the lower 2nd molars, and restore both missing first molars with fixed prostheses.

Option 2. Nonextraction approach: close the LR space, prepare the LL space for an implant-supported prosthesis, place bite turbos to correct the deepbite, and protract the lower arch with Class II elastics in an L-configuration to correct the overjet.

After considering the pros and cons of each option, the patient preferred Option 2 because it was the most conservative, but she understood it was a very challenging treatment plan that depended on patient compliance to protract the entire lower dentition with Class II elastics. Following preprosthetic alignment and implant placement, the fixed appliances would be used to retain the space and finish the occlusion during the healing period. Remove the fixed appliances when the implant-supported prosthesis is delivered. Retain both arches with clear overlay retainers worn full-time for 6 months and then nights only.

Treatment Progress

A full-fixed 0.022-in slot Damon Q® bracket system (*Ormco, Glendora, CA*) was selected along with the archwires and accessories specified by the manufacturer. High torque was selected for maxillary brackets (*U1 22˚, U2 13˚, U3 11˚*), and standard torque for mandibular brackets (*L1 -3˚, L2 -3˚, L3 7˚*). Brackets were bonded on both arches at the start of treatment (*Fig. 8*), but the flexible archwire 0.014-in copper-nickel-titanium (*CuNiTi*) was not engaged in the lower molars because it was likely to be displaced by masticatory function.

In the 4th month, the bracket was bonded on the LR8, the mandibular archwire was changed to 0.014x0.025-in CuNiTi and all brackets were engaged on the archwire. An open coil spring with light force was used on the LL side to help upright the second molar and increase the space for an implant. On the LR side, the molars were uprighted by the force of the archwire (*Fig. 9*). Anterior bite turbos (*BTs*) were applied on the palatal surfaces of the maxillary central incisors to create inter-maxillary space to help upright the mandibular molars, and intrude the central incisors to correct the 4mm overbite. Light Class II elastics (*Parrot 5/16-in, 2-oz*) were used from the upper canines to lower 2nd premolars bilaterally to begin correction of the sagittal discrepancy.

■ *Fig. 8*:
In the 1st month of the treatment (1M), the 0.014-in CuNiTi archwire was used to engage all of the maxillary teeth, but a similar archwire is cut-off distal to the 5s, and the end of the wire is encased in polymerized resin (blue arrows) for patient comfort.

■ *Fig. 9*:
In the 4th month (4M), the mandibular archwire was changed to 0.014x0.025-in CuNiTi that was extended into the L7 tubes to deliver an uprighting moment that did not extrude the teeth. An open coil spring (blue arrow) with light force (~10cN) was used on the LL side to open space as the second molar was uprighted. See text for details regarding these non-extrusive mechanics.

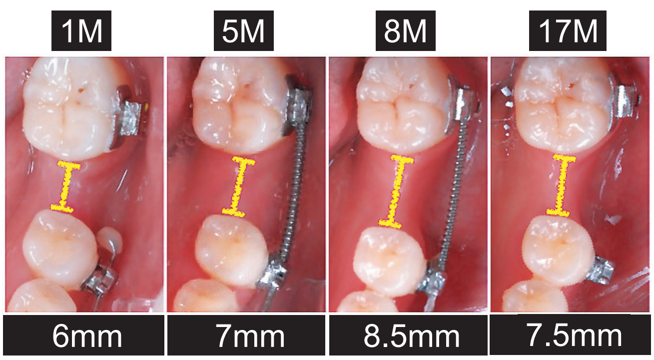
In the 8th month, the maxillary archwire was changed to 0.017x0.025-in titanium-molybdenum-alloy (*TMA*) and the mandibular archwire was fitted 0.016x0.025-in SS. An open coil spring was still used on the LL side to retain the space opening. The LR molars were sufficiently uprighted to apply power chains to close the space. Modified L-type Class II elastics (*Fox 1/4-in, 3.5-oz*) were applied bilaterally from the upper canines to the lower 2nd premolar and extended to the 2nd molar. This configuration was designed to protract the lower dentition with minimal bite opening (*Fig. 10*). The LL implant site 8.5mm in length, which was 1mm more than deemed ideal.

In the 10th month, the lower midline had shifted about 2mm to the right, so the L-type Class II elastics (*Fox 1/4-in, 3.5-oz*) were used only on the right side until the asymmetry was corrected. Once the midlines were coincident, the L-type Class II elastics were again used bilaterally.

After 17 months of active treatment, the preprosthetic alignment was complete for the LL implant, and all other spaces were closed. Fig. 11 shows the progressive photographs of the implant site preparation. The midline and overjet were corrected as documented in Fig. 12.

■ *Fig. 10:*

In the 8th month (8M), the archwires were 0.017x0.025-in TMA in the maxillary arch and 0.016x0.025-in SS in the mandibular arch. An open coil spring was used on the LL side to retain the space (blue arrow). The LR molars were sufficiently uprighted to apply power chains to close the space. Modified L-type (configuration) Class II elastics (green lines) were applied bilaterally to simultaneously resolve the sagittal discrepancy, assist LR space closure, reduce the missing LL 1st molar space, and control bite opening. See text for details.



■ *Fig. 11:*

Progressive photographs for the first 17 months of LL implant site preparation show that the previously insufficient space (6mm) was increased to an excessive space (8.5mm) with the open coil spring as the LL 2nd molar was uprighted with a moment delivered with the archwire. The distance was gradually reduced to an ideal 7.5mm arch length by sliding mechanics on the 0.016x0.025-in SS wire with power chains and the Class II L-type elastics.

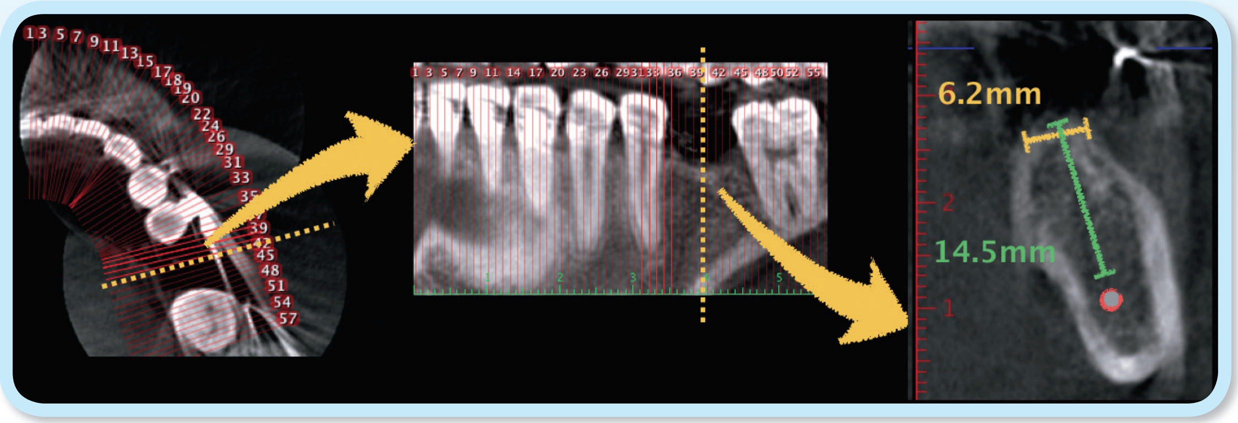
Fig. 12:
Before treatment (0M) the lower midline discrepancy was 1mm to the right which was stable during the first month of treatment (1M). In the 8th month (8M), the midline discrepancy increased to 2-3mm due to the asymmetric mechanics: space closure on the LR and space opening on the LL. The midline discrepancy was corrected by the 17th month (17M) of treatment by using a unilateral L-type Class II elastic on the right side since the 10th month of treatment.

Implant Placement

At 17 months into active treatment, preprosthetic alignment was completed, and a cone-beam computed tomography (*CBCT*) scan were taken. A slice from the center of the implant site was selected and the alveolar bone mass was measured: Height 14.5mm, Width 6.2mm. The anatomical structure of the implant site was studied in multiple slices of the 3D image, and the mental foramen was located (*Fig. 13*). An implant fixture (*Ø4.3x12mm*) from the A+ System®, produced by MegaGen® (*Taiwan*) was chosen. A surgical stent was designed following the 2B-3D rule[12] for precise implant placement to achieve an optimal gingival margin in all three dimensions: mesial-distal (*M-D*), buccal-lingual (*B-L*) and axial.

Under local anesthesia, a #15c scalpel blade was used for a mid-crestal incision. A sulcular incision was performed with a #12 blade from the distal line angle of LL5 to the mesial line angle of LL7 on the buccal surface, and a full thickness soft tissue flap was reflected (*Fig. 14c*). Exposure of the bone revealed an adequate ridge to place a 4.3-mm diameter implant (*Fig. 14d*). A surgical stent was fitted to guide the first lancer drill for the initial osteotomy (*Fig. 14e*), and the guide pin was placed. A periapical film was exposed to check the insertion path and orientation of the osteotomy as revealed by the guide pin (*Figs. 14f and g*).

Following the specifications of the implant manufacturer, the fixture was installed in the center of the ridge according to the 2B-3D rule:[12] 2mm



■ *Fig. 13:*
A CBCT scan shows the implant preparation in the axial (left), sagittal (middle) and frontal views. The alveolar bone volume height was 14.5mm, and the width was 6.2mm. Anatomic details are noted such as the cortical thickness and trabecular pattern of bone in the site, in addition to the inferior alveolar nerve (red circle) and the mental foramen.

buccal bone thickness and fixture 3mm apical to the expected crown margin (*Figs. 14h and i*). As shown in Figs. 14j and k, the fixture was connected with a healing abutment (*Ø5.0mm x H5.0mm*), and the flap was sutured with interrupted 5-0 GORE-TEX® (*Flagstaff, AZ*) (*Fig. 14l*). After 1 week, the sutures were removed and the prosthesis delivery was planned following a 6-month healing interval.

Orthodontic Finishing Stage

As shown in Figs. 15a and b, the implant fixture was not in the middle of the osseous ridge in the mesial-distal direction. The periapical film showed that the 2nd molar had been tipped mesially, so the distances from the fixture to the premolar and molar were not equal. Flowable resin was added on the mesial side of the activated open coil spring to provide force for uprighting the 2nd molar and increasing the space to the implant (*Fig. 15c*). In the 18th month, 0.016x0.025-in SS archwires were placed on both arches for finishing adjustments.

After 23 months of active treatment, all fixed appliances were removed and clear overlay retainers were delivered. The patient was instructed to wear the retainers full time. Following completion of the final crown for the LL6 implant, a new clear retainer was made.

Implant Prothesis Fabrication

After 6 months of healing, the implant was well integrated, so the healing cap was replaced with a multi-post abutment (*Ø5.0mm, 4.0mm cuff height, and 5.2mm post height*). A torque ratchet was applied at 35 N-cm to seat and secure the abutment in the planned position. Occlusal clearance exceeded 2mm which was deemed adequate to construct a porcelain fused to metal crown (*Figs. 16a-d*).

A coping and post-level analog were chosen to transfer the level of the abutment, and a snap impression was made using polyvinyl siloxane impression material. The impression was poured

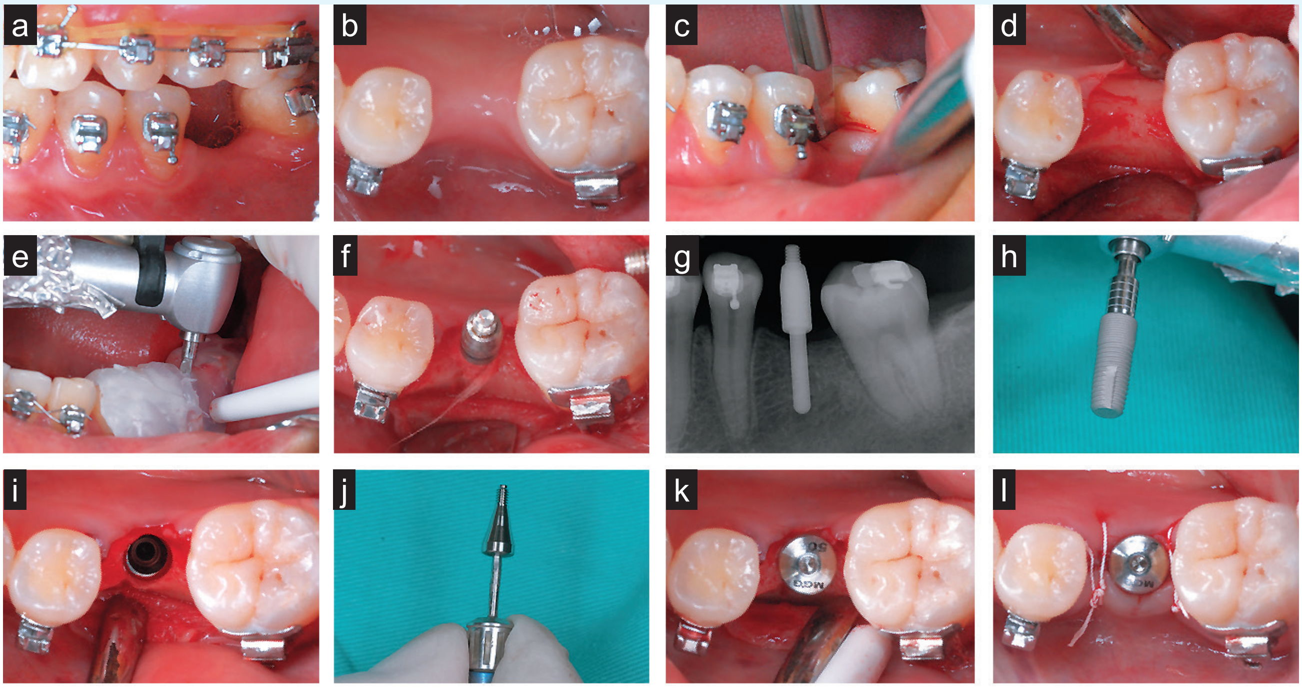


Fig. 14:

Restoration of the LL 1st molar space is illustrated as follows: (a) LL 2nd molar was uprighted and moved mesially to produce a 7.5mm implant space, (b) occlusal view of the prepared implant site, (c) mid-crestal and sulcular incisions were performed for flap reflection, (d) occlusal view of the exposed osseous ridge, (e) a surgical stent was designed for precise implant placement in three dimensions, (f) a guide pin was placed in the osteotomy, (g) a periapical film was taken with the guide pin to check the insertion path and orientation of the osteotomy, (h) a 4.3x12mm implant fixture, (i) occlusal view of the osseous ridge with the implant fixture installed, (j) a 5.0x5.0mm healing abutment (cap), (k) the healing abutment was installed, and (l) the flap was sutured with direct loop interrupted 5-0 GORE-TEX®.

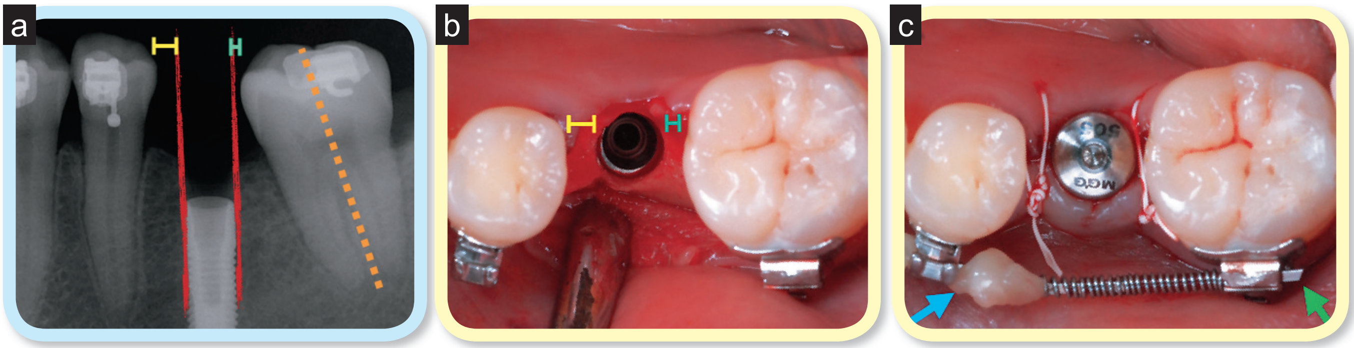


Fig. 15:

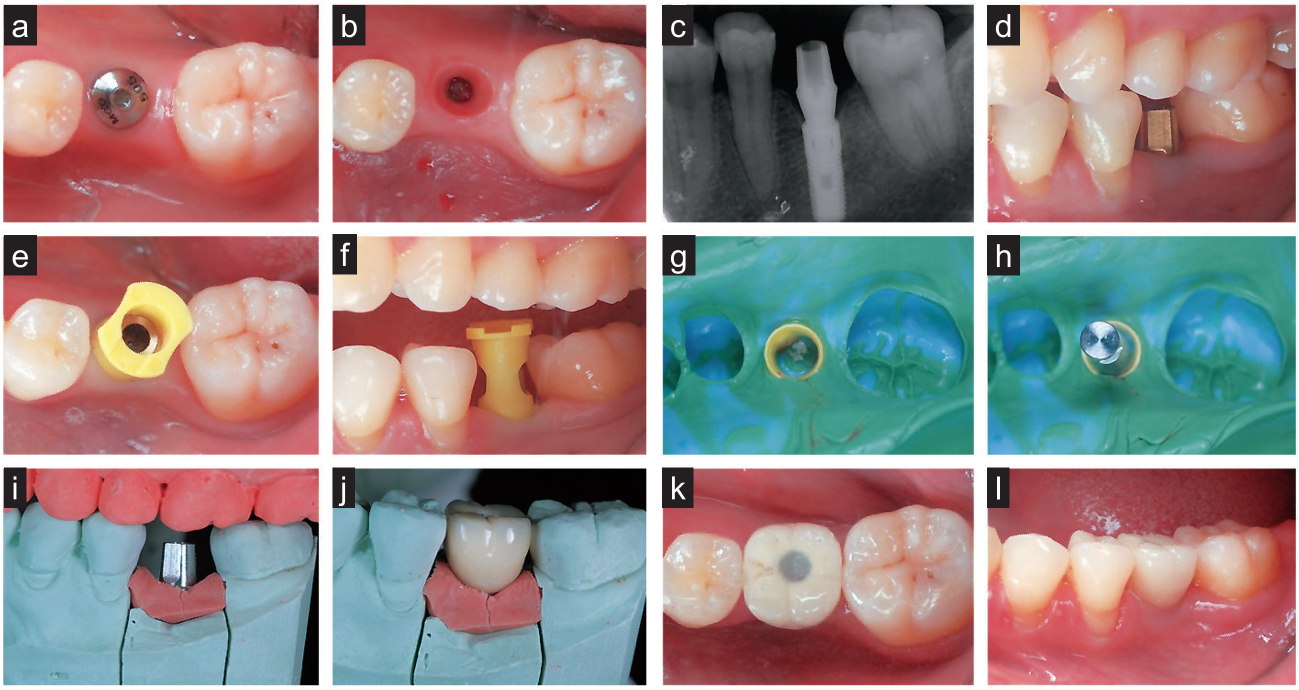
(a) A periapical radiograph showed that the 2nd molar was tilted mesially, so the distances from the fixture to premolar and molar were not equal (yellow compared to green lines), (b) An occlusal radiograph documented that the implant was not in the center of the osseous ridge in mesial-distal direction (yellow compared to green lines). (c) Flowable resin was added on the mesial side of the compressed open coil spring (blue arrow) to provide force to upright the 2nd molar. Note that the end of the archwire was extended distal to the molar tube (green arrow) to avoid being disengaged as the molar moved distally.

with Type IV dental stone to prepare a working cast (*Figs. 16e-h*).

When the final prosthesis was seated, appropriate tightness of the contact area was confirmed with dental floss. The occlusal area was made of porcelain because of the patient's esthetic concerns (*Figs. 16i and j*). After clinical adjustment and verification of the fit and occlusion, the permanent crown was completed and retained with temporary cement. After the screw access hole was filled with composite resin, the final prosthesis is shown in Figs. 16k and l. A new clear mandibular overlay retainer was made after completion of the implant-supported crown. The patient was instructed to wear the retainers full time for the first 6 months and nights only thereafter. Home care and retainer maintenance instructions were provided.

Treatment Results

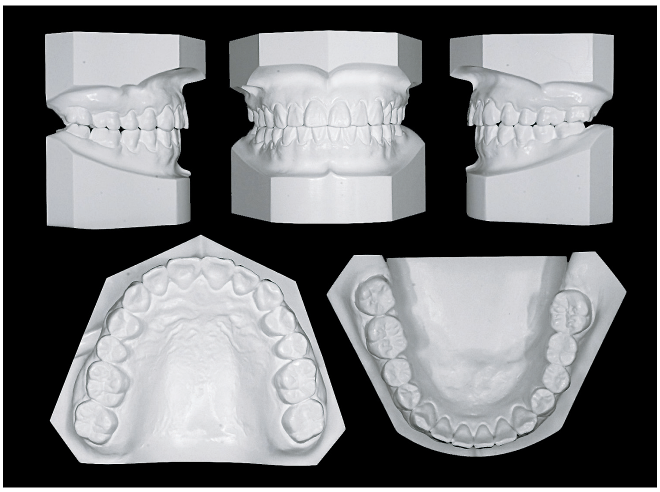
Protraction of the lower dentition, relative to the apical base of bone, produced increased lower lip protrusion, resulting in a more balanced lower facial profile. Intermaxillary alignment was excellent (*Figs. 17 and 18*), as reflected in the Cast-Radiograph



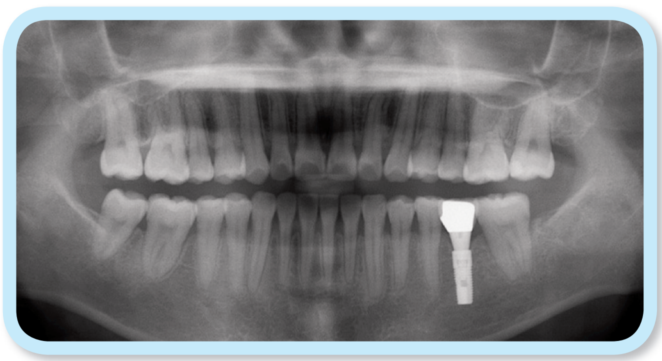
■ *Fig. 16:*

The prosthesis fabrication procedure is illustrated: (a) Healing abutment in place. (b) After abutment removal, the soft tissue sulcus is seen along with minimal bleeding points in the non-keratinized buccal mucosa. (d) From the buccal 2mm of inter-occlusal clearance is noted as required for a porcelain fused to metal crown. (e) A "snap" impression coping is inserted into the soft tissue sulcus. (f) From the buccal view the snap coping is securely seated. (g) A pick-up impression with polyvinyl siloxane shows the yellow outline of the impression coping. (h) The corresponding implant analog was "snapped" into the coping embedded in the impression. (i) The impression was poured in type IV dental stone to prepare a working cast. (j) The final prosthesis was fabricated and fitted on the working cast. (k) The occlusal view of the crown is luted with temporary cement. (l) The permanent crown is viewed from the buccal aspect.

■ *Fig. 17: Post-treatment facial and intraoral photographs*



■ *Fig. 18: Post-treatment dental models (casts)*

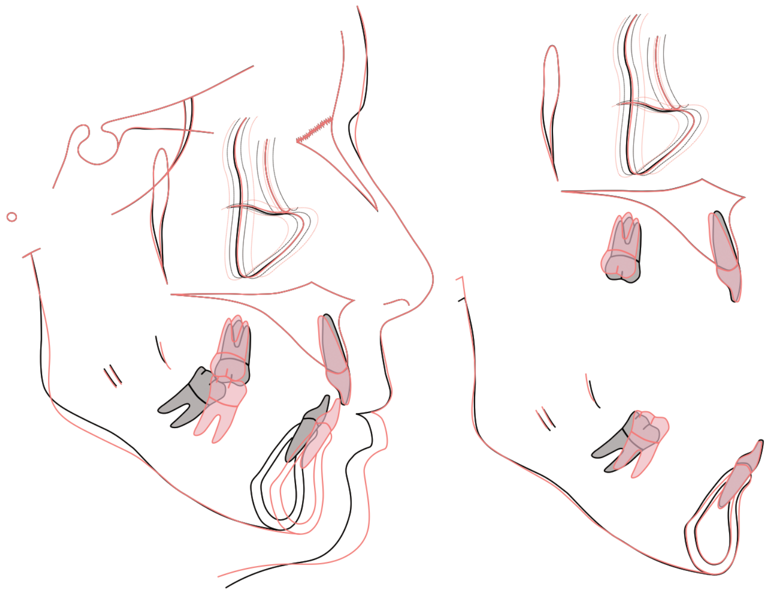


■ *Fig. 19: Post-treatment panoramic radiograph*

Evaluation (*CRE*)[13] score of 19 (*Worksheet 2 attached at the end of the report*). The most significant discrepancy was slight overjet in the incisal region (*4 points*). Dental midlines and axial inclinations of the dentition as well as the implant-supported prosthesis were near ideal (*Figs. 17-20*).

The post-treatment cephalometric film (*Fig. 20*) and superimposed tracings (*Fig. 21*) showed that the retrusive lower lip was improved, resulting in a more balanced facial profile. The sagittal inclination of the maxillary incisors was increased 5˚ to accommodate the desired protraction of the mandibular dentition. At the finish, the axial inclinations of the incisors were decreased for the upper and increased for the lower, consistent with correction of Class II malocclusion in an adult (*Table 1*). However, the dentofacial result was a remarkable improvement for a Class II patient presenting with missing lower first molars bilaterally (*Fig. 21*). The post-treatment TMJ

■ *Fig. 20: Post-treatment lateral cephalometric radiograph*



■ *Fig. 21:*

Superimposed cephalometric tracings showing dentofacial changes over 23 months of treatment (red) compared to the pre-treatment position (black). The retrusive lower lip was corrected, resulting in a more balanced facial profile. The axial inclination was increased for both the maxillary and mandibular incisors. The maxillary molars were slightly retracted while the LL 2nd molar was protracted to substitute for the missing 1st molar. See text for details.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	85°	85°	0°
SNB° (80°)	78°	81°	3°
ANB° (2°)	7°	4°	3°
SN-MP° (32°)	38°	35°	3°
FMA° (25°)	31°	28°	3°
DENTAL ANALYSIS			
U1 TO NA mm *(4 mm)*	0 mm	-1 mm	1 mm
U1 TO SN° (104°)	95°	100°	5°
L1 TO NB mm *(4 mm)*	5 mm	4 mm	1 mm
L1 TO MP° (90°)	92°	92°	0°
FACIAL ANALYSIS			
E-LINE UL *(2-3 mm)*	-1 mm	-3 mm	2 mm
E-LINE LL *(1-2 mm)*	-2 mm	-1 mm	1 mm
Convexity: G-Sn-Pg' *(13°)*	14°	9°	5°
%FH: Na-ANS-Gn *(53%)*	56.4%	57.2%	0.8%

■ Table 1: Cephalometric summary

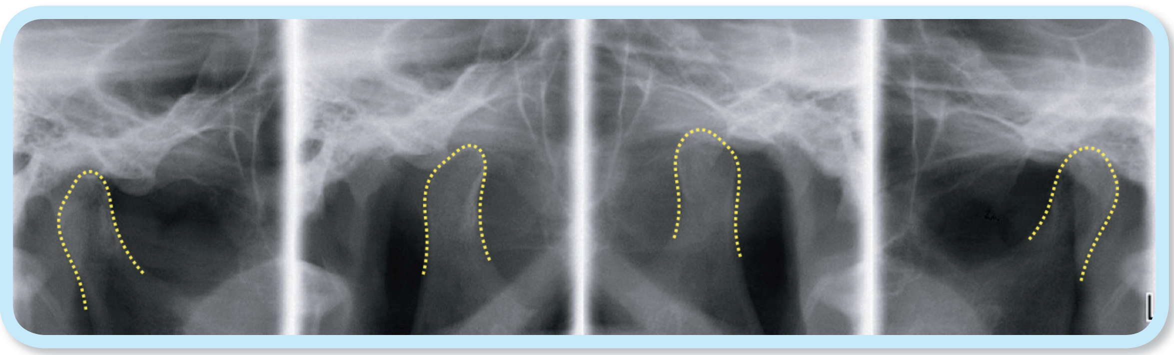
radiographs documented that both condylar heads were well positioned in the fossa and symmetrical with the mandible opened and closed (*Fig. 22*). Following cosmetic gingival contouring,[14] the Pink and White dental esthetic score was 3 points, as documented in Worksheet 3 at the end of this report.

Overall, the conservative approach for managing this challenging malocclusion was quite successful. Defining the etiology of the skeletal malocclusion as a functional retrusion due to MIH as a child increased the confidence that this conservative approach was appropriate. She was well satisfied with both the improved esthetics and function.

Discussion

Uprighting lower second molars

A mesially tipped molar is usually uprighted by tipping the crown distally.[9] However, a *"false"* extrusion/eruption can occur with the crown tipping due to pure rotation at the center of resistance (C_R).[8] The occlusal surface of the tipped tooth is



■ *Fig. 22:*
Post-treatment TMJ radiographs show that mandibular contours and articular relationships are WNL for both on the right and left sides. The open and closed positions for the right TMJ are shown in the two images on the left side, and the same relationships for the left TMJ are shown on the right side of the illustration.

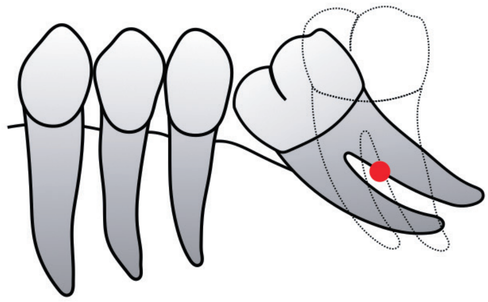
aligned along the occlusal plane without extruding relative to the apical base of bone (*Fig. 23*). The latter uprighting method is a reversal of the etiology by which the second molar tipped into the missing first molar space. Since non-intrusive mechanics were used to upright the second molars,[8] anterior BTs were indicated to intrude the incisors (*Fig. 24*), for correction of the anterior overbite, without opening the lower facial height (*Fig. 21*). The L-configuration of the Class II elastics also helped control the vertical dimension of occlusion (*VDO*) because of the vertical component of force from the maxillary canines to the lower second premolars (*Fig. 10*).

There were three keys to uprighting the tipped mandibular second molars without extrusion (*Fig. 25*):

(1) Full fixed appliance with an 0.014x0.025-in CuNiTi archwire that extends through the tubes on the lower second molars.

(2) Molar tubes were placed with a more gingival orientation on the mesial aspect of the bracket to intensify the root uprighting moment,[15] resulting in equal and opposite moments on the second molars and the anterior segment of the dentition.

(3) The force on the open coil spring was very low to avoid overpowering the moment provided by the archwire.[16,17] If the force from the coil spring is too great, the molar will be uprighted primarily by the moment of the force, which results in a



■ *Fig. 23:*
Rotation of the tooth around the C_R is anticipated from the application of a moment, when there is little no distal force applied. Although the molar is not actually extruded, the uprighting may cause occlusal prematurities as the axial inclination of the molar is corrected. The problem can be corrected with occlusal adjustment of the molar or leveling the occlusal plane of the entire buccal segment.

■ *Fig. 24:*
Anterior BTs (red arrow) were used to create intermaxillary clearance to upright the tipped molars and align the lower buccal segments. The mechanics were used with Class II elastics in an L-configuration to help control bite opening as the lower curve of Spee was corrected. See Fig. 10.

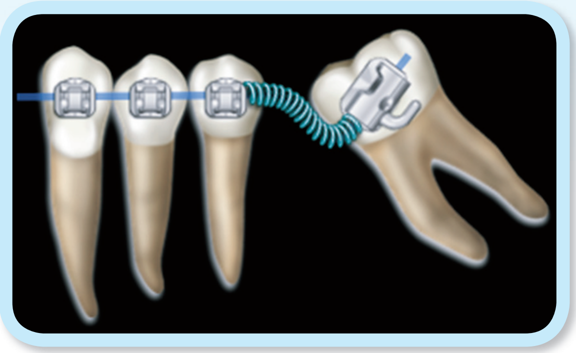


Fig. 25:

Mechanics to upright the second molars with rotation near the C_R and minimal extrusion to open the bite were: (1) highly flexible 0.014-in CuNiTi archwire, (2) open coil spring with very light force, and (3) bonding the bracket with a mesial rotation to position the anterior portion of the bracket closer to the gingiva. See text for details.

center of rotation (C) that is apical to the C_R and the molar will extrude,[18,19] due to the inclined plane effect of the root engaging the tapered alveolus.[20]

No open coil spring was used on the LR side because the LR 1st molar space was to be closed. The advantages of these 3 keys are that they contain no auxiliaries, such as push springs, T-loops, and hooks; therefore, patients can be treated with a simple routine orthodontic treatment.

Rate Of Mesial Translation Of Mandibular Molars

Treatment time is an important consideration in planning the mesial translation of mandibular molars into missing L6 sites with a probable MIH etiology. Roberts, Arbuckle and Analoui[18] described the bone physiology of 2nd and 3rd mandibular molar protraction into a missing 1st molar space. The relatively flat roots of the molars move through the center of the alveolar process by resorbing primarily trabecular bone on the mesial surface and forming cortical bone on the distal surface of each root. For the first few millimeters of tooth movement, the molars move rapidly, but when the trailing root engages the cortical bone formed by the leading root, the rate of molar protraction decreases.[18] Ricketts et al.[21] proposed that cortical bone is more resistant to resorption than trabecular bone because of a lack of internal vascularized spaces.

Roberts, Arbuckle and Analoui[18] reported that: (*1*) sustained orthodontic translation is a physiological manifestation of bone modeling and remodeling throughout the adjacent alveolar process, and (2) the rate of mandibular molar translation is inversely related to the apparent radiographic density of the resisting alveolar bone. Theoretically a tooth can move at the linear rate of resorption at the PDL/bone interface,[22] but reactivations, adjustments and engagement of progressive archwires produces repeated areas of PDL necrosis that inhibit the rate of tooth movement and enhance the incidence of root resorption.[19]

Asymmetric Mechanics

Asymmetric space closure and opening mechanics can result in midline changes.[23] The treatment plan for the current patient with an initial midline deviation 1mm to the right (*Fig. 1*) was to close the 1st molar space on the LR side, and increase the space on the LL side to produce a site for an implant-supported crown. The net effect for these asymmetric mechanics was to increase the deviation of the lower midline to the right. This problem was successfully managed with asymmetric Class II elastics; only the left Class II elastic was worn until the midline were coincident. Then bilateral Class II L-configuration elastics were used to complete the intermaxillary correction (*Fig. 17*). This approach required excellent patient compliance which was discussed at the pretreatment consultation. It is important to inform the patient that TADs and/or asymmetric interproximal enamel reduction (*IPR*) may be required if the deviation is greater than expected or compliance is inadequate. IPR is a particularly effective alternative if there are black interdental spaces and/or a tooth size discrepancy.[24]

Orthopedic Correction

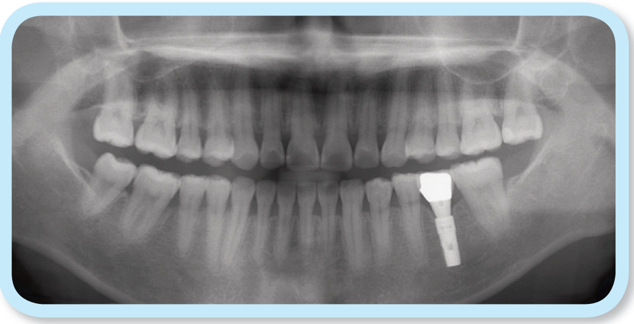
Treatment time for conservative correction of acquired skeletal Class II malocclusion with a probable MIH etiology depends on the rate of tooth movement,[18] management of the symmetry if needed (*Fig. 12*), and orthopedic correction (*Fig. 21*). The rate of tooth movement is the limiting factor for aligning or restoring the missing L6 spaces.[18] Continuous mechanics with low PDL stress[24] is the goal for uprighting the mesially tipped L7s with CuNiTi archwires and mesially rotated brackets (*Fig. 25*). Orthopedic correction of the skeletal discrepancy due to an apparent functional retrusion can be

Fig. 26: *Two-year post-retention facial and intraoral photographs*

accomplished in adults with functional orthopedics[25] or a spontaneous correction with bite turbos and Class II elastics (*Figs. 10, 21 and 24*). The critical factors for achieving orthopedic correction in adults are correction of the inhibition(s) followed by mechanics to encourage a more anterior posturing of the mandible. Long-term follow-up of Class II division 1 malocclusion in adults treated with functional orthopedics shows that little of the orthopedic effect is retained but the Class I correction is stable.[26] On the other hand, spontaneous orthopedic correction from functional retrusion with bite turbos and L-type Class II elastics appears to be quite stable (*Figs. 26-29*). Additional studies on the long-term follow-up are needed to confirm this promising approach.

2 years follow-up

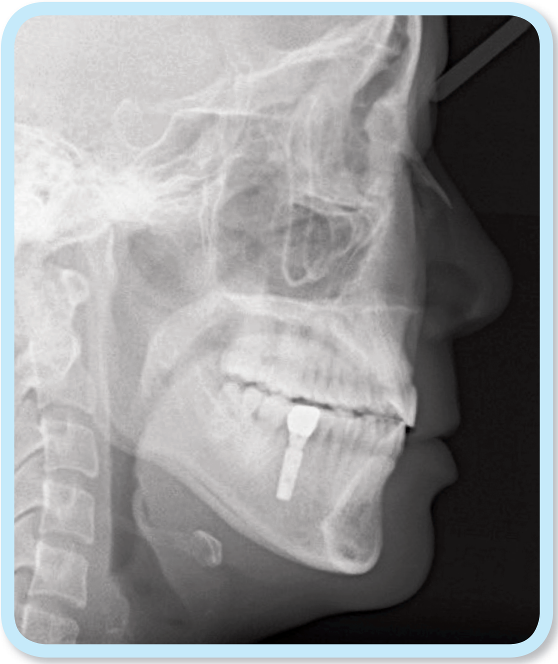
Two years after treatment was completed, the patient was asked to return for a follow-up evaluation. The treatment results were stable and the occlusion had improved with better occlusal contacts in the buccal segments (*Fig. 26*). The post-retention panoramic radiograph shows good osseous health for the mesially protracted LR 2nd and 3rd molars, as well as for the implant-supported prosthesis (*Fig. 27*). The lateral cephalometric radiograph and superimposed tracings document a stable mesial movement of the lower dentition relative to the basilar mandible. It was particularly gratifying to note that the residual overjet of the incisors was resolved (*Figs. 28 and 29*). The post-retention TMJ images show the length, size and position of the condylar heads were maintained, and there were no signs or symptoms of temporomandibular disorder (*Fig. 30*).



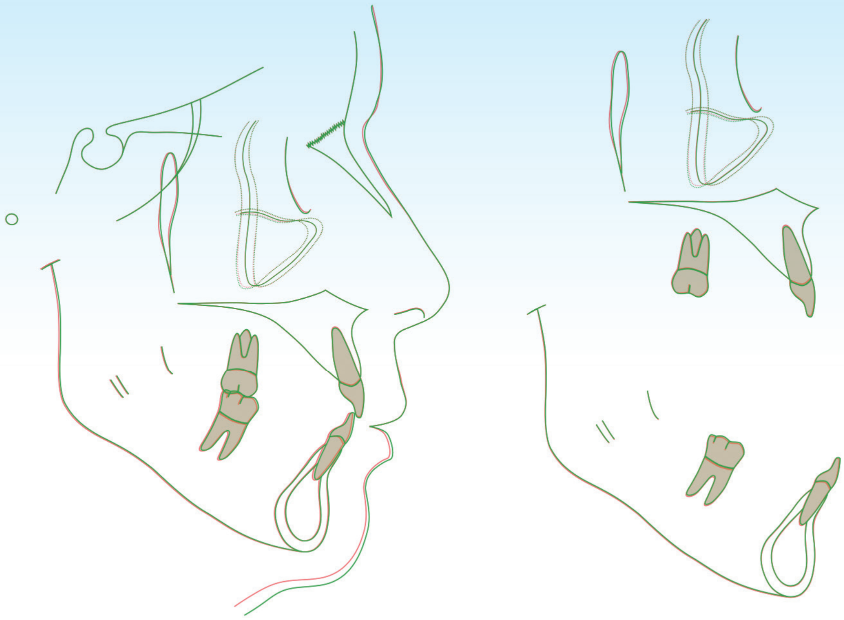
■ *Fig. 27*: *Two-year post-retention panoramic radiograph*

Conclusions

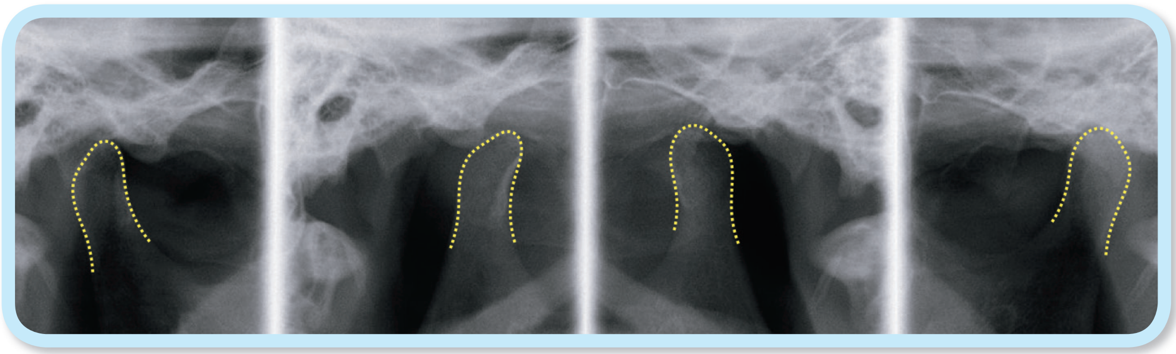
(1) MIH-related loss of mandibular first molars is a common etiology for an acquired Class II malocclusion, either unilateral of bilateral. Early loss of both mandibular first molars often produces a distinctive acquired malocclusion: mesially tipped second molars, deep curve of Spee, mandibular retrusion, decreased axial inclination of maxillary incisors, with deep-bite and/or increased overjet.



■ *Fig. 28*: *Two-year post-retention lateral cephalometric radiograph*



■ *Fig. 29*:
Superimposed cephalometric tracings show two-year post-retention dentofacial changes (green) compared to the post-treatment position (red). The mandible moved forward to improve the occlusal relationship, and the immediate post-treatment 1mm of overjet was corrected.



■ *Fig. 30*:
Two-year post-retention TMJ radiographs show form and function is WNL. The right TMJ is shown in the left two images, and the left TMJ is shown in the right two images. The two center images are with the mandible opened, while the far left and far right images are with the mandible closed.

(2) If the lower 3rd molar is present, space closure is usually the best option, but when it is absent, space opening and an implant-supported crown is preferable.

(3) Defining the etiology of an acquired malocclusion is important for understanding the potential for a functionally retruded mandible to readapt (*"grow"*) into a more anterior position. MIH-related Class II malocclusions can usually be managed with conservative mechanics designed to upright second molars, remove functional interference with bite turbos, and protract the mandibular dentition without opening the bite (*VDO*).

(4) Midline discrepancies are controlled with unilateral intermaxillary elastics in an L-configuration.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 24

OVERJET

0 mm. (edge-to-edge)	=		
1 – 3 mm.	=	0 pts.	
3.1 – 5 mm.	=	2 pts.	4mm
5.1 – 7 mm.	=	3 pts.	
7.1 – 9 mm.	=	4 pts.	
> 9 mm.	=	5 pts.	

Negative OJ (x-bite) 1 pt. per mm. per tooth =

Total = 2

OVERBITE

0 – 3 mm.	=	0 pts.	
3.1 – 5 mm.	=	2 pts.	4mm
5.1 – 7 mm.	=	3 pts.	
Impinging (100%)	=	5 pts.	

Total = 2

ANTERIOR OPEN BITE

0 mm. (edge-to-edge), 1 pt. per tooth
then 1 pt. per additional full mm. per tooth

Total = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

1 – 3 mm.	=	1 pt.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	4 pts.
> 7 mm.	=	7 pts.

Total = 2

4mm (upper)

OCCLUSION

Class I to end on	=	0 pts.	
End on Class II or III	=	2 pts. per side	____pts.
Full Class II or III	=	4 pts. per side	4 pts.
Beyond Class II or III	=	1 pt. per mm. additional	____pts.

Total = 4

Full Class II (right)

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB $\geq$ 6° or $\leq$ -2° = 4 pts.

Each degree < -2° ________x 1 pt. = ________

Each degree > 6° ________x 1 pt. = ________

SN-MP

$\geq$ 38° = 2 pts.

Each degree > 38° ________x 2 pts. = ________

$\leq$ 26° = 1 pt.

Each degree < 26° ________x 1 pt. = ________

1 to MP $\geq$ 99° = 1 pt.

Each degree > 99° ________x 1 pt. = ________

Total = 2

OTHER (See Instructions)

Supernumerary teeth	________	x 1 pt. =	________
Ankylosis of perm. teeth	________	x 2 pts. =	________
Anomalous morphology	________	x 2 pts. =	________
Impaction (except 3rd molars)	________	x 2 pts. =	________
Midline discrepancy (≥3mm)		@ 2 pts. =	________
Missing teeth (except 3rd molars)	2	x 1 pts. =	2
Missing teeth, congenital	________	x 2 pts. =	________
Spacing (4 or more, per arch)	1	x 2 pts. =	2
Spacing (Mx cent. diastema ≥ 2mm)		@ 2 pts. =	________
Tooth transposition	________	x 2 pts. =	________
Skeletal asymmetry (nonsurgical tx)		@ 3 pts. =	________
Addl. treatment complexities	2	x 2 pts. =	4

Identify: Molar protraction x2 (right 2nd & 3rd molars)

Total = 8

IMPLANT SITE

Lip line : Low (0 pt), Medium (1 pt), High (2 pts) =_

Gingival biotype : Low-scalloped, thick (0 pt), Medium-scalloped, medium-thick (1 pt), High-scalloped, thin (2 pts) =_ 2

Shape of tooth crowns : Rectangular (0 pt), Triangular (2 pts) =_

Bone level at adjacent teeth : ≦ 5 mm to contact point (0 pt), 5.5 to 6.5 mm to contact point (1 pt), ≧ 7mm to contact point (2 pts) =_

Bone anatomy of alveolar crest : H&V sufficient (0 pt), Deficient H, allow simultaneous augment (1 pt), Deficient H, require prior grafting (2 pts), Deficient V or Both H&V (3 pts) =_

Soft tissue anatomy : Intact (0 pt), Defective (2 pts) =_ 2

Infection at implant site : None (0 pt), Chronic (1 pt), Acute(2 pts) =_

Total = 4

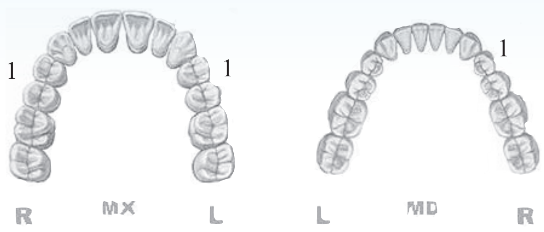
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 19

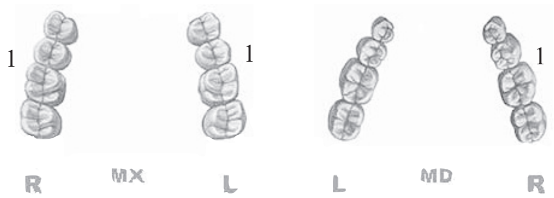
Alignment/Rotations

3



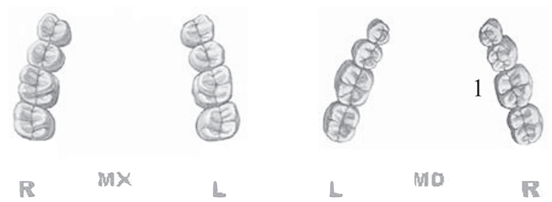
Marginal Ridges

3



Buccolingual Inclination

1

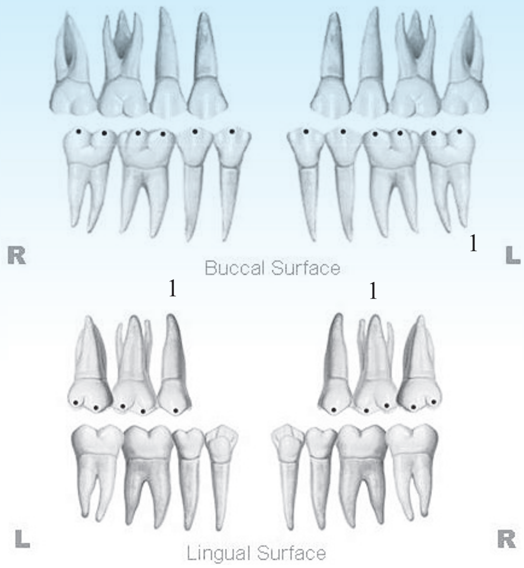


Overjet

4

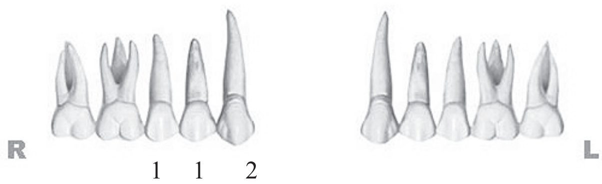
Occlusal Contacts

3



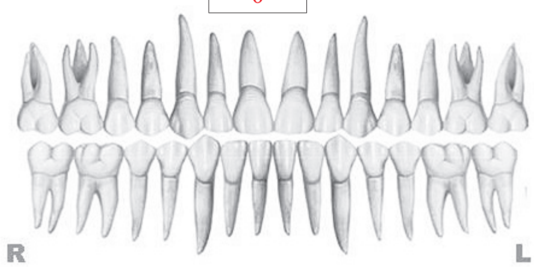
Occlusal Relationships

4



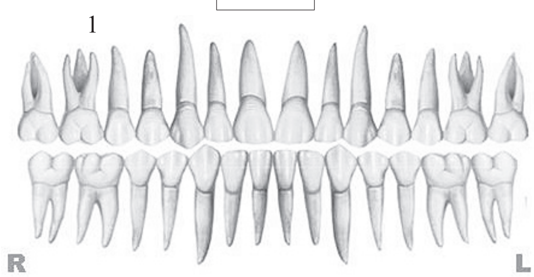
Interproximal Contacts

0



Root Angulation

1



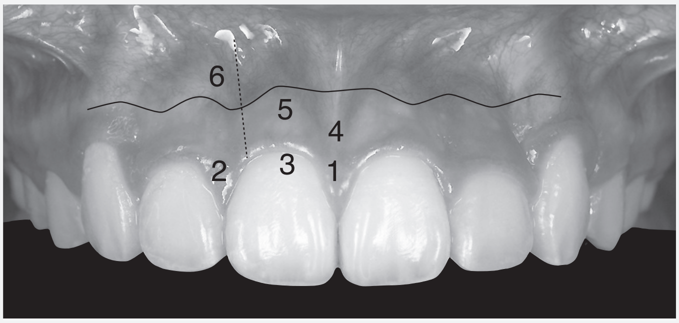
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score (Before Surgical Crown Lengthening)

Total Score: = 3

1. Pink Esthetic Score

Total = 1

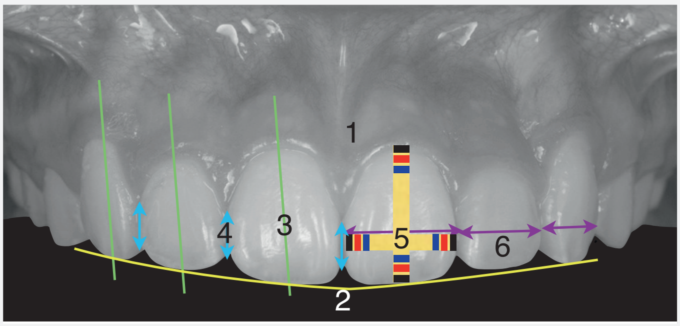


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

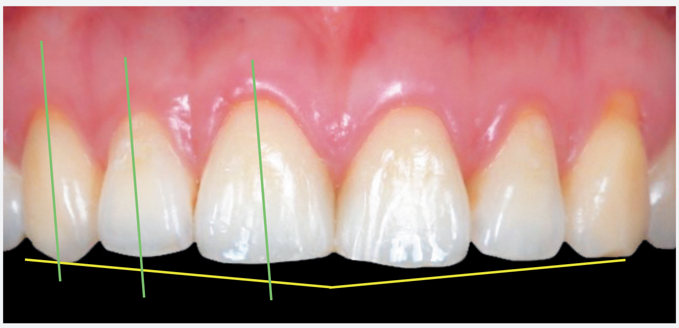
1. M & D Papilla	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 2



1. Midline	0	1	2
2. Incisor Curve	0	1	2
3. Axial Inclination (5°, 8°, 10°)	0	1	2
4. Contact Area (50%, 40%, 30%)	0	1	2
5. Tooth Proportion (1:0.8)	0	1	2
6. Tooth to Tooth Proportion	0	1	2



1. Midline	0	1	2
2. Incisor Curve	0	1	2
3. Axial Inclination (5°, 8°, 10°)	0	1	2
4. Contact Area (50%, 40%, 30%)	0	1	2
5. Tooth Proportion (1:0.8)	0	1	2
6. Tooth to Tooth Proportion	0	1	2