

Class III Malocclusion, Anterior Crossbite and Missing Mandibular First Molars: Bite Turbos and Space Closure to Protract Lower Second Molars

Abstract

Diagnosis: A 32-year-old female presented with a long face (55%), maxillary retrusion (SNA 79.5°), mandibular protrusion (SNB 82.5°), retruded lips (-4.0/-3.5mm), relative lower lip protrusion, missing lower first molars (LR6, LL6), atrophic edentulous spaces, Class III buccal segments, and anterior crossbite. The Discrepancy Index (DI) was 25.

Etiology: Early loss of L6s was probably due to molar-incisal hypomineralization (MIH). Anterior crossbite is a common functional compensation after lower second deciduous molars are lost at about age 12yr.

Treatment: A passive self-ligating (PSL) appliance, posterior bite turbos, early light short Class III elastics were used to correct the anterior crossbite. The L6 extraction sites were closed with primarily Class II elastics. Active treatment time was 20 months.

Results: Closure of the atrophic L6 sites was achieved by retracting the anterior segment and protracting lower molars. No significant root resorption nor periodontal problems were noted. The patient was pleased with treatment: excellent occlusal function, improved dentofacial esthetics, and an attractive smile arc. Clinical outcomes were a cast-radiograph evaluation (CRE) of 21 and a Pink & White (P&W) dental esthetic score of 3.

Conclusions: Severe skeletal malocclusion was corrected in 20 months with a full-fixed PSL appliance, posterior bite turbos, intermaxillary elastics, and space closure mechanics. (*J Digital Orthod* 2019;56:48-63)

Key words:

Missing first molar, mesially tipped molar, atrophic edentulous ridge, anterior crossbite, passive self-ligating brackets, Class III elastics

Introduction

Many patients with a skeletal Class III malocclusion view surgery as the only viable option. However, that is an over treatment for patients with a good profile, near Class I molar relationship, and/or an anterior functional shift. It is essential to consider the etiology and differentially diagnose the malocclusion before formulating a treatment plan. If a centric relation (C_R) to centric occlusion (C_O) discrepancy exists, the problem is best classified as a pseudo Class III malocclusion.¹ Pseudo Class III patients who have an orthognathic profile in C_R usually have a good prognosis for conservative treatment.

Dr. Ashley Huang,
Lecturer, Beethoven Orthodontic Course (Left)

Dr. Angle Lee,
Editor, Journal of Digital Orthodontics (Center left)

Dr. Chris H. Chang,
President, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center Right)

Dr. W. Eugene Roberts,
Editor-in-chief, Journal of Digital Orthodontics (Right)



■ Fig. 1: Pre-treatment facial and intraoral photographs in C_0



■ Fig. 2: Functional assessment of mandible movement: intraoral photographs in C_R

Diagnosis and Etiology

A 32-year-old woman sought orthodontic evaluation for missing teeth, poor dentofacial esthetics, and a protrusive lower lip (Figs. 1-3). Radiographic examination included a lateral cephalometric film, panoramic radiograph, and a temporomandibular (TMJ) joint series (Figs. 4-6). Cephalometric analysis revealed a long face, retrusive maxilla, and protrusive mandible (Table 1). No contributing medical history was reported, but isolated loss of permanent first molars is usually due to a medically-related dental developmental problem in the toddler years: molar-incisor hypomineralization (MIH).² In adults, closing edentulous L6 spaces is challenging because of associated malocclusion, atrophic knife-edge ridge, and anchorage requirements.³⁻⁵ An anterior crossbite may be associated with MIH, but it can be a fortunate occurrence that increases anchorage for L7 protraction.³

Facial evaluation showed symmetrical structures, a concave profile, retrusive lips to the E-Line, but a relative protrusion of the lower lip. An unattractive reverse smile arc was evident while smiling. The panoramic radiograph (Fig. 5) revealed missing L6s and U8s bilaterally, retained root tip in the LR6 area, and mesial tipping of the L7s. Intraoral examination showed missing teeth (UR8, UL8, LR6, and LL6), residual root tip in the area of the LL6, anterior crossbite of all four maxillary incisors, buccal crossbite of the UL7, maxillary dental midline coincident with the facial midline, mandibular dental midline 1mm to the left, and a C_O-C_R discrepancy (anterior functional shift) from an initial edge-to-edge position (Figs. 1-3). Pre-treatment cephalometric

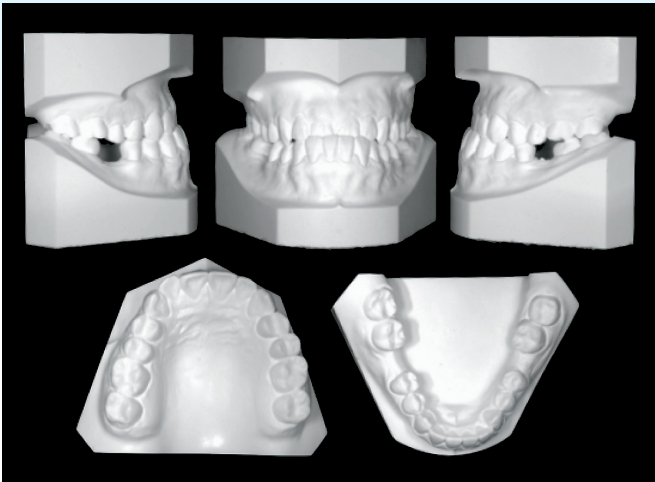
evaluation confirmed the skeletal Class III (ANB -3°) as previously described (Fig. 4; Table 1), but the excessive SNB angle was partially due to the C_O-C_R discrepancy. The TMJ radiographs (Fig. 6) showed symmetric unremarkable morphology and there were no signs or symptoms of TMJ dysfunction. The American Board of Orthodontics (ABO) discrepancy index (DI) was 25 points,⁵ as shown in the worksheet at the end of this report.

Treatment Objectives

The treatment objectives were: (1) extract the hopeless lower left first molar residual root; (2)

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	79.5°	79.5°	0°
SNB° (80°)	82.5°	83°	0.5°
ANB° (2°)	-3°	-2.5°	0.5°
SN-MP° (32°)	35°	36°	1°
FMA° (25°)	27°	28.5°	1.5°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	2 mm	2.5 mm	0.5 mm
U1 To SN° (110°)	103°	106°	3°
L1 To NB mm (4 mm)	0 mm	-1 mm	1 mm
L1 To MP° (90°)	77°	72°	5°
FACIAL ANALYSIS			
E-LINE UL (-1 mm)	-4 mm	-4 mm	0 mm
E-LINE LL (0 mm)	-3.5 mm	-1.5 mm	2 mm
%FH: Na-ANS-Gn (53%)	55%	55.2%	0.2%
Convexity: G-Sn-Pg' (13°)	2°	1.5°	0.5°

■ Table 1: Cephalometric summary



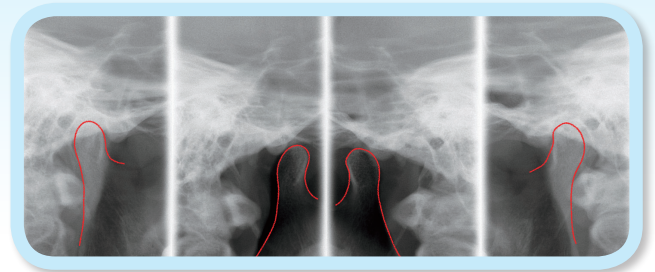
■ Fig. 3: Pre-treatment dental models (casts)



■ Fig. 4: Pre-treatment lateral cephalometric radiograph



■ Fig. 5: Pre-treatment panoramic radiograph



■ Fig. 6:
Pre-treatment TMJ radiographic series from left to right are: closed right, open right, closed left, and open left.

correct the anterior crossbite by opening the bite and retracting the lower anterior segment, (3) protract the mandibular molars to close space, and (4) correct the maxillary anterior smile arc.

Treatment Alternatives

Uprighting the L7s and leaving the space for implant-supported crowns was considered. That option may decrease treatment time, but it was more expensive and invasive. Also, the buccolingual width of the atrophic edentulous ridges required augmentation bone grafts. After carefully considering the pros and cons for each option, the patient selected orthodontic space closure.

Treatment Progress

The patient was referred for removal of the residual LL6 root, and one month later, Damon Q® passive self-ligating (PSL) 0.022-in brackets (Ormco, Glendora, CA) were bonded on all permanent teeth. All elastics, archwires and auxiliaries were produced by the same manufacturer. Standard torque brackets were used on all teeth except: 1. low torque brackets on the maxillary incisors, 2. low torque brackets

bonded up-side-down (*to express high torque*) on the mandibular incisors, and 3. high torque brackets on L3s. Archwire materials were copper nickel-titanium (*CuNiTi*), titanium molybdenum alloy (*TMA*), and stainless steel (*SS*). The maxillary archwire sequence was: 0.014-in *CuNiTi*, 0.014x0.025-in *CuNiTi*, 0.017x0.025-in *TMA*, and 0.016x0.025-in *SS*. The corresponding lower arch sequence was 0.014-in *CuNiTi*, 0.014x0.025-in *CuNiTi*, 0.016x0.025-in pre-Q *NiTi* (*20° of lingual root torque in the anterior segment*), 0.019x0.025-in pre-Q *NiTi*, and 0.016x0.025-in *SS*. In the first month of active treatment, posterior bite turbos were constructed with Fuji II type II glass ionomer cement (*GC America, Alsip IL*) on the occlusal surfaces of the mandibular second molars. The patient was instructed to wear the short Class III elastics (*Quail 3/16-in, 2oz*) from the upper first molars to the lower first premolars bilaterally, to correct the anterior crossbite (*Fig. 7*). Bilateral bite turbos

were effective for unlocking the interdigitation and facilitating overjet and overbite correction. In the 4th month of treatment, a positive overjet was achieved and the bite turbos were removed (*Fig. 8*). To enhance space closure efficiency and to control iatrogenic rotation, four lingual buttons were bonded on the lower first premolars and the second molars. A sequence of 0.016x0.025-in Pre-Q *NiTi* and 0.019x0.025-in Pre-Q *NiTi* wires were installed in the lower arch in the 4th and 6th months respectively, to increase incisors torque. In the 8th month, Class II elastics (*Bear 1/4-in, 4.5-oz*) were applied bilaterally from the maxillary canines to the mandibular 2nd molars for 3 months to complete the A-P correction and promote smile arc development (*Fig. 9*). Fifteen degree root lingual third order bends in 0.016x0.025-in *SS* archwires were applied to mandibular incisors in the 9th month and to the maxillary incisors in the 15th month (*Figs. 10 and 11*). In the 12th month,



Fig. 7: In the 1st month of the treatment, the 0.014-in *CuNiTi* archwires engaged in all dentition of both arches. The anterior crossbite was corrected with bite turbos (blue circles), alignment of the maxillary anterior segment, and 2-oz Class III elastics (blue lines). Class III elastics provide horizontal and vertical forces to facilitate early correction of anterior crossbite.



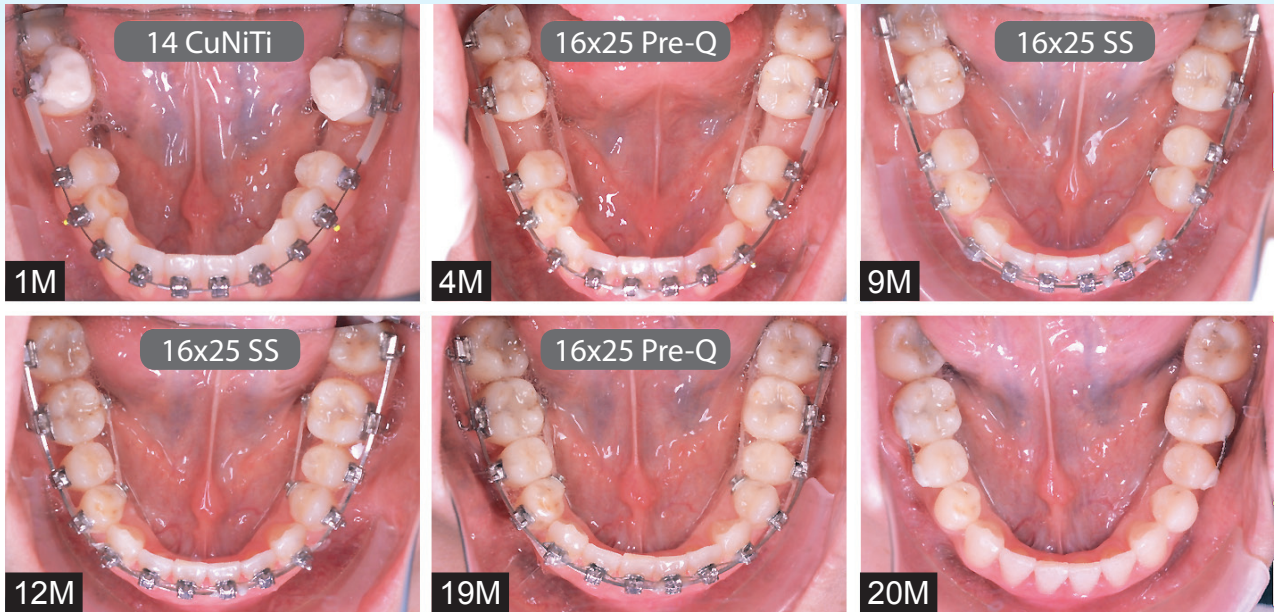
Fig. 8:
 In the 4th month, anterior crossbite was corrected. The maxillary archwire was changed to 0.014x0.025-in CuNiTi, and the mandibular archwire was changed to 0.016x0.025-in Pre-Q NiTi.



Fig. 9:
 In the 9th month, maxillary and mandibular archwires were changed to 0.016x0.025-in SS. Class II elastics (blue lines) were applied for A-P correction, and to prevent uprighting of the lower anterior teeth during space closure.



Fig. 10:
 Maxillary arch form was corrected from one (1M) to twenty (20M) months with the archwire sequence as shown. In the 9th month of treatment, third order bends applied +15 degrees of lingual root torque on maxillary incisors.



■ Fig. 11:

In the 1st month of the treatment (1M), posterior bite turbos were bonded on the occlusal surfaces of the mandibular second molars. In the 4th month of treatment (4M), buttons were bonded on the lingual surfaces of the mandibular first premolars and second molars. Power chains were applied on the buccal and lingual surfaces from 9-19mo (9M-19M) to close the lower posterior spaces. In the 12th month, the extraction spaces were closed. Third order bends were placed in the 15th month to deliver +15 degrees of lingual root torque to the mandible incisors. By nineteen months (19M) the correction was complete and the fixed appliances were removed at twenty months (20M).

the extraction spaces were closed. Brackets were repositioned based on a progress panoramic radiograph. Inter-proximal reduction (IPR) of the mandibular central incisors was performed to correct the dark interproximal triangles, and to reduce arch-length to permit an ideal overjet correction. Fixed appliances were removed after 19 months of active treatment. Two fixed retainers were bonded buccally between the mandibular second premolars and the second molars to maintain space closure. Retention was provided with maxillary and mandibular clear overlay retainers.

Treatment Results

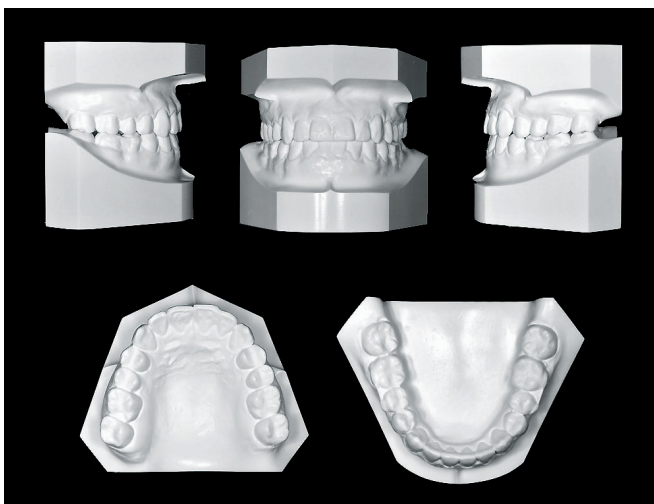
Facial esthetics with a more harmonious facial profile were achieved by a modest increase in lower facial

height and retraction of the lower anterior segment (Fig. 12). The maxillary anterior segment has well aligned with a pleasing smile arc.⁶ Dental midlines were aligned on the facial midline, and normal overbite and overjet were achieved (Fig. 13). The post-treatment panoramic and cephalometric films (Figs. 14 and 15) revealed harmonious axial inclinations in the buccal segments with all interproximal spaces closed. An unusual external apical root resorption was noted. The cephalometric analysis revealed that the upper incisor to SN angle was increased 5 degrees, and the SNB angle was decreased from 84 to 81 degrees (Table 1). Superimposition of cephalometric tracings from before and after treatment showed that the mandibular anterior segment was retracted about 5mm, and was lingually inclined about 4 degrees. Mandibular



■ Fig. 12:

Post-treatment facial and intraoral photographs show two fixed retainers (blue arrows) bonded on the buccal surfaces of the mandibular second premolars and the second molars.



■ Fig. 13: Post-treatment dental models (casts)

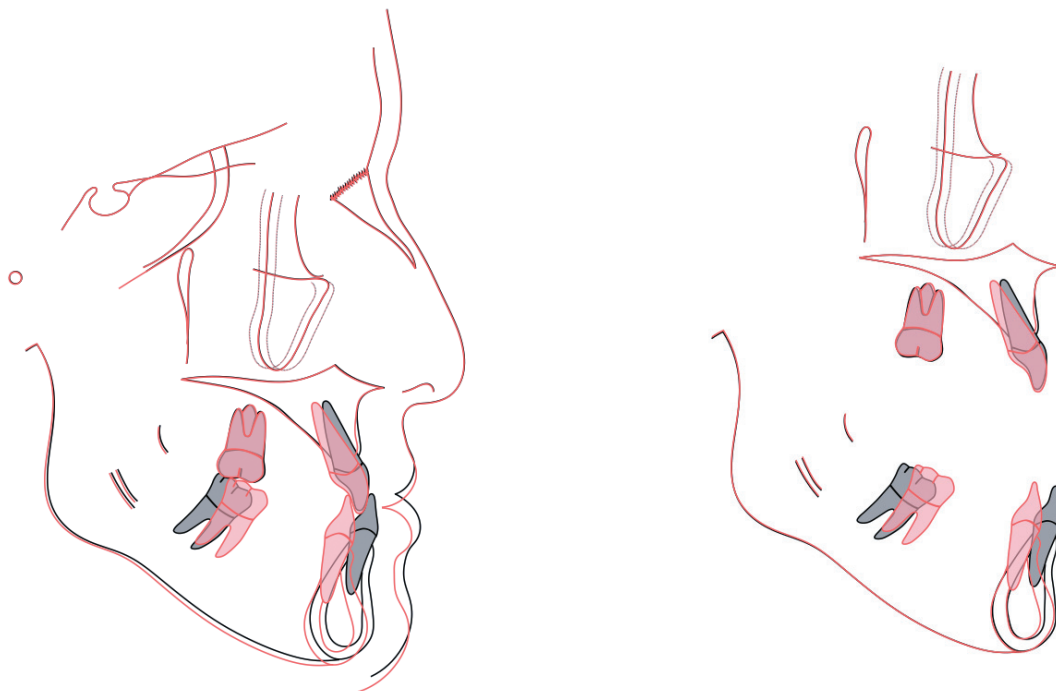
second and third molars were protracted, uprighted, and extruded, which was associated with ~1 degree clockwise rotation of the mandible (Fig. 16). The patient was well satisfied with the treatment results. The ABO cast radiograph evaluation (CRE) score was 21 points,⁷ as shown in the worksheet at the end of this report. The major alignment discrepancies were marginal ridges and buccolingual inclination of the molars. Substituting mandibular third molars for second molars may be challenging because of morphologic variabilities of the crown. The Pink and White (P&W) esthetic score was 3 points,⁸ which



■ Fig. 14: Post-treatment lateral cephalometric radiograph



■ Fig. 15: Post-treatment panoramic radiograph



■ Fig. 16:

Superimposed cephalometric tracings showing dentofacial changes after 19 months of treatment (red) compared to pre-treatment (black). The protrusive lower lip was corrected, resulting in a more balanced facial profile. Maxillary incisor axial inclination was increased 5° and mandibular incisors were retracted ~5mm. The mandibular second molar(s) was protracted and substituted for the missing 1st molar(s).

reflected gingival prominence on the UR1. Attrition on the incisal edges of the 4 maxillary incisors was due to occlusal interference before orthodontic treatment. Two-year-follow-up intraoral photographs showed stable occlusion and a harmonious curvature of gingival margins (Fig. 17).

Discussion

Differential diagnosis of skeletal Class III malocclusion with an anterior crossbite is essential for formulating an efficient treatment plan. Treatment options are orthodontic treatment with or without orthognathic surgery. Class III patients with an acceptable profile and near Class I molar relationship in C_R are good candidates for conservative orthodontic treatment particularly if there is a pretreatment $C_R \rightarrow C_O$ functional shift. If the latter is present, the diagnosis is pseudo Class III malocclusion.¹ In C_R the present patient had a straight facial profile, Class I molar relationship, and an anterior functional shift to achieve C_O . These

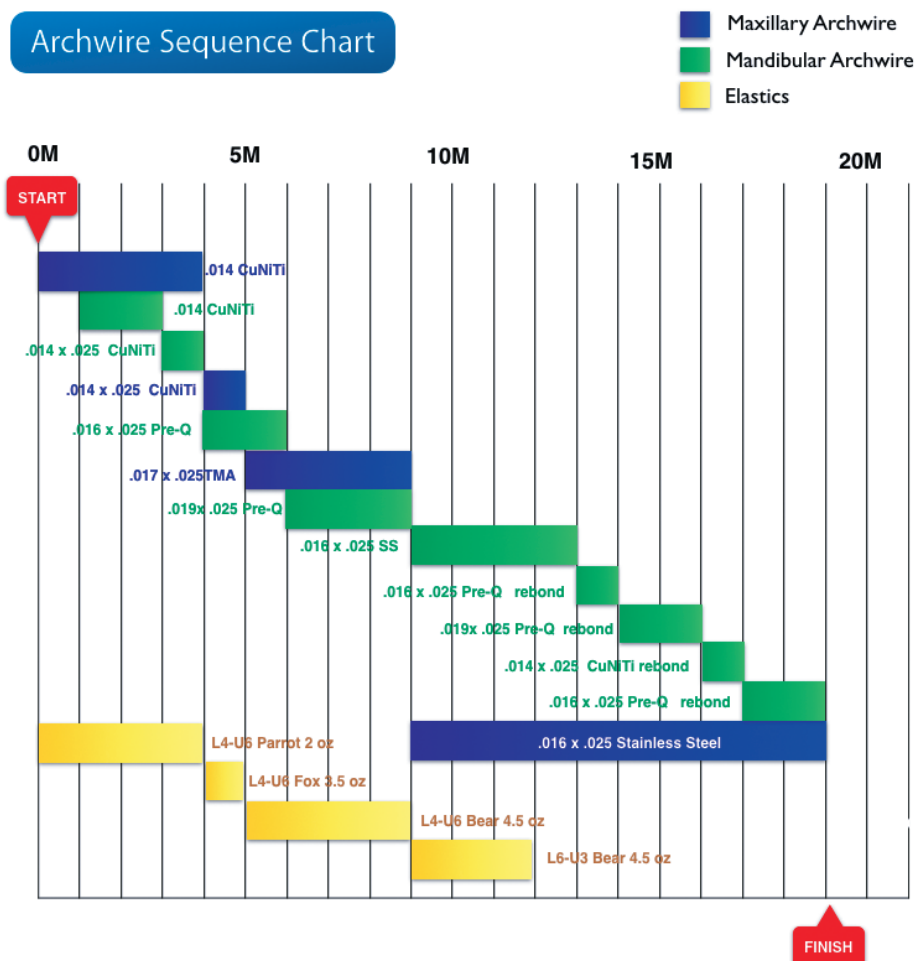


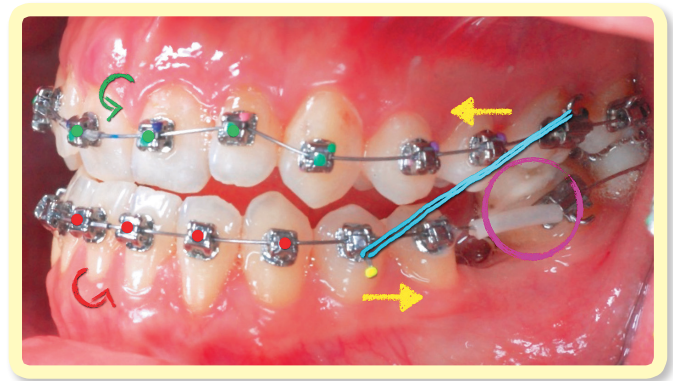
Table 2: Archwire sequence chart



■ Fig. 17: 2-year-follow-up intraoral photographs

diagnostic features suggested a good response to dentoalveolar treatment. Posterior bite turbos on L7s and light force Class III elastics facilitated the anterior crossbite correction and retracted the lower premolars. After only 3 months of active treatment, a positive overjet was achieved.

Upper incisors flare when crowding is corrected without extraction or interproximal reduction, and the problem is enhanced with Class III elastics. To control maxillary incisal flaring, low torque brackets (+7 and +3) are indicated for central and lateral incisors, respectively. Class III elastics tip lower incisors lingually, so high torque brackets are indicated. There are no high torque brackets available for lower incisors, so low torque brackets



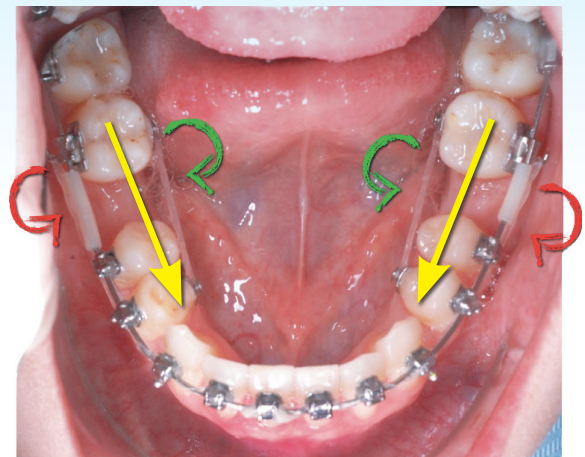
■ Fig. 18: Conservative correction of anterior crossbite with Class III elastics (blue line) tends to flare maxillary incisors and tip mandibular incisors lingually (yellow arrows). Decreased torque is required in upper incisor brackets (green arrow) and increased torque in lower incisor brackets (red arrow). The posterior bite turbos (purple circle) unlock the interdigitation to permit retraction of the lower anterior segment.

are bonded up-side-down to achieve the desired torque (Fig. 18).

Missing mandibular first molar is common among adult orthodontic patients.¹⁻³ Since the L6s are lost early due to MIH,² the L7s tip mesially into the space, and the edentulous ridge becomes atrophic. Stepovich⁹ found that L6 extraction sites can be closed if the edentulous ridge is 6 mm or less in mesiodistal length and ~7mm in buccolingual width. For the present patient, the mesiodistal dimensions were 7mm on the left, 8mm on the right, and the buccolingual alveolar bone widths were >8mm on both sides. After 19 months of treatment, the extraction sites closed and the axial inclination in the buccal segments were WNL (Fig. 15).

Extra-oral devices such as a facemask are relatively inefficient, but retromolar endosseous implants are effective indirect anchorage for protracting lower molars.¹⁰ Miniscrews are used for anchorage reinforcement,¹¹⁻¹³ but there may be problems with adequate sites and screw movement during molar protraction.^{14,15} Conservative space closure is effective when intermaxillary force is used and retraction of the lower anterior segment is desirable (Figs. 7-16). Protraction of lower molars with intra-arch mechanics results in retraction of the lower anterior segment.¹⁶ For the present patient, the extraction space was used to align the teeth and correct the negative overjet, so there was no need for anchorage reinforcement.

Large dimension rectangular wires help control axial inclinations during space closure. Closing spaces



■ Fig. 19:

Closing space with sliding mechanics (yellow arrows) on a heavy SS rectangular wire is facilitated by balancing lingual (green arrows) and buccal moments (red arrows) to avoid the tendency for mesial and lingual tipping and iatrogenic rotation of the second molars.

with sliding mechanics on a heavy SS rectangular wire is facilitated by balancing lingual and buccal forces to prevent iatrogenic rotation (Fig. 19). Space re-opening of the mandibular first molar extraction sites may occur after appliances are removed. Fixed retention for mandibular posterior space closure is indicated.¹⁷

Conclusions

1. Differential diagnosis of Class III malocclusion with anterior crossbite requires an evaluation of the facial profile, molar classification, and functional shift. Differentiating between the true and the pseudo Class III malocclusions is essential when predicting prognosis and also for preventing over-treatment.
2. Closing mandibular extraction sites controls treatment costs by eliminating the need for

surgical and restorative procedures. However, control of the mechanics for tooth movement is also important. Dividing buccal and lingual force on a heavy archwire prevents rotation as well as mesial and/or lingual tilting of the second molar.

Reference

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Discrepancy Index Worksheet

TOTAL D.I. SCORE = 25

OVERJET

- 0 mm. (edge-to-edge) =
- 1 – 3 mm. = 0 pts.
- 3.1 – 5 mm. = 2 pts.
- 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 = **8**

Total = 8

OVERBITE

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

Total = 0

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 = 1

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 _____pts.
- Beyond Class II or III = 1 pt. per mm. _____pts.
additional

Total = 0

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 1

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB $\geq 6^\circ$ or $\leq -2^\circ$ = 4 pts.

Each degree $< -2^\circ$ 1 x 1 pt. = 1

Each degree $> 6^\circ$ _____ x 1 pt. = _____

SN-MP

$\geq 38^\circ$ = 2 pts.

Each degree $> 38^\circ$ _____ x 2 pts. = _____

$\leq 26^\circ$ = 1 pt.

Each degree $< 26^\circ$ _____ x 1 pt. = _____

1 to MP $\geq 99^\circ$ = 1 pt.

Each degree $> 99^\circ$ _____ x 1 pt. = _____

Total = 5

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 (≥ 3 mm) _____ @ 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 ≥ 2 mm) _____ @ 2 pts. = _____
- Tooth transposition _____ x 2 pts. = _____
- Skeletal asymmetry (nonsurgical tx) _____ @ 3 pts. = _____
- Addl. treatment complexities 3 x 2 pts. = 6

Identify: **Molar protraction x2**
CO/CR discrepancy

Total = 10

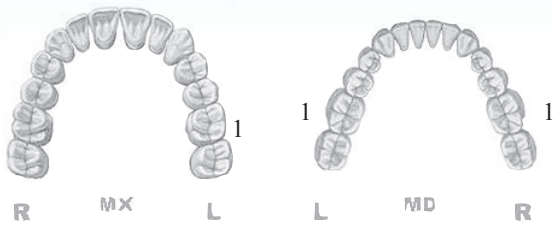
Cast-Radiograph Evaluation

Case # Patient

Total Score: **21**

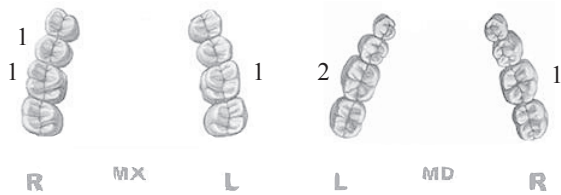
Alignment/Rotations

3



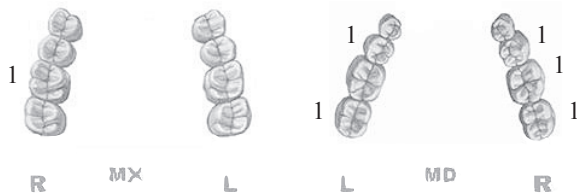
Marginal Ridges

6



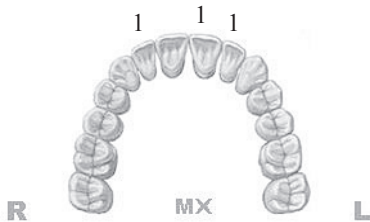
Buccolingual Inclination

6



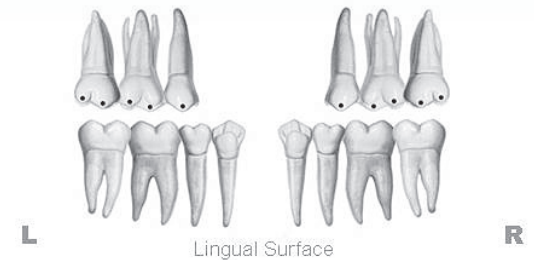
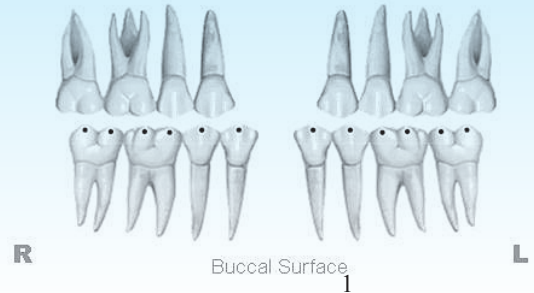
Overjet

3



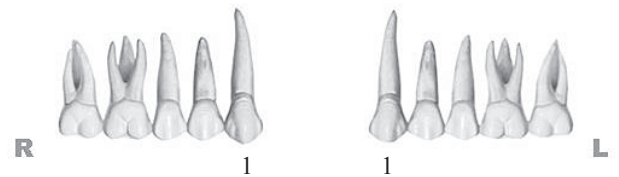
Occlusal Contacts

1



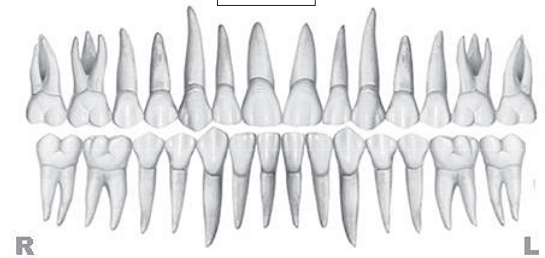
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2



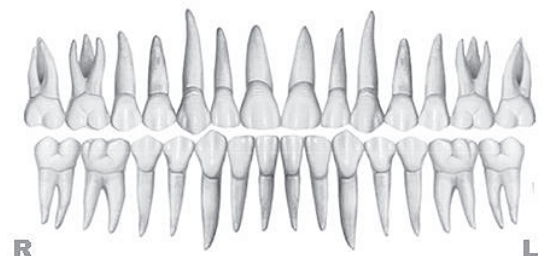
Interproximal Contacts

0



Root Angulation

0

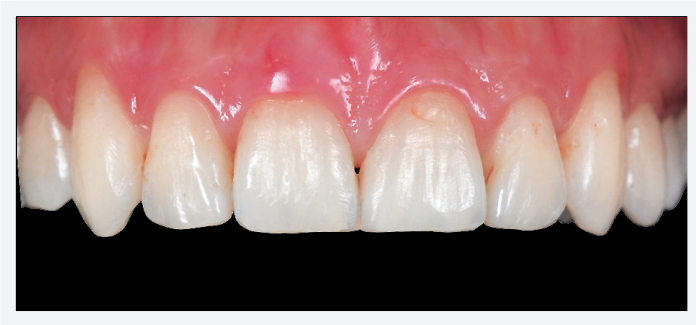
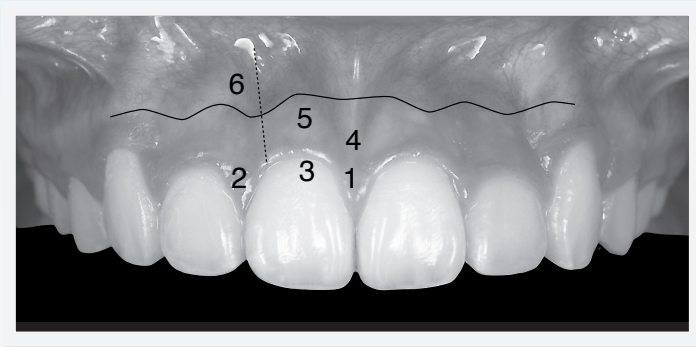


INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 3

1. Pink Esthetic Score

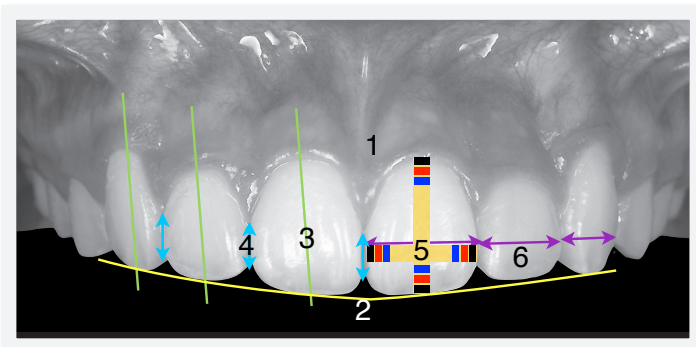


Total = 1

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

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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