Non-Extraction Treatment of Pseudo-Class III Anterior Cross-Bite Complicated by Severe Crowding, Deep-Bite and Clenching

Abstract

Anterior cross-bite is a major esthetic and functional concern for patients and their parents. Based on the Lin 3-ring diagnosis, a 13 year-old boy was diagnosed as a pseudo-Class III malocclusion, associated with anterior cross-bite (overjet = -3mm), deep-bite (overbite = 8mm), severe crowding (-9/-2mm), concave profile, and inadequate maxillary incisor exposure. There was an anterior functional shift on mandibular closure, and the mandible could be manipulated to an edge-to-edge incisal occlusion, when the condyles were positioned in centric relation. The Discrepancy Index (DI) was 23. A passive self-ligation appliance, bite turbos on lower first molars, and early light short intermaxillary Class III elastics (ELSE) were used to correct this severe malocclusion in only 20 months. The Cast-Radiograph Evaluation (CRE) score was 23. At the finish, several morphologic features were noted that appear to reflect parafunction (clenching): relatively deep-bite, increased axial inclination (flaring) of the maxillary incisors, and the mandibular plane failed to open as expected. The flared maxillary incisors resulted in an unfavorable Pink & White dental esthetic score of 6. Long term follow up is indicated to control parafunction, open the bite, retract the maxillary incisors, and evaluate the potential for late mandibular growth to produce a skeletal Class III malocclusion. (J Digital Orthod 2018;50:78-94)

Key words:

pseudo-Class III, non extraction, crowding, cross-bite, deep-bite, passive self-ligating appliance, parafunction, clenching

Introduction

A 13 year-old male presented for orthodontics consultation with blocked-out maxillary canines, severe crowding, anterior cross-bite and deep overbite. He had a decreased vertical dimension of occlusion (*VDO*), lip redundancy, mildly concave profile, and a slightly protrusive lower lip (*Figs. 1-3*). This case report demonstrates effective treatment with passive self-ligating brackets, open coil springs, and early light short elastics (*ELSE*), bilaterally. Conservative treatment was completed in 20 months without extractions or orthognathic surgery. The key to efficient treatment was an accurate diagnosis. It is important to define the etiology, and design a treatment plan that effectively reverses it.

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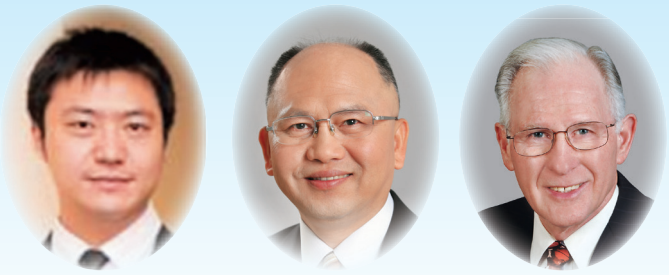


Fig. 1: Pre-treatment facial photographs, 13 y/o male

Fig. 2: Pre-treatment intraoral photographs

Fig. 3: Pre-treatment study models (casts)

Diagnosis

The chief complaint was poor dental esthetics and function due to an anterior cross-bite. Medical and dental histories were non-contributory. A functional examination revealed that the mandible could be manipulated from centric occlusion (C_O) to a centric relation (C_R) to achieve an edge-to-edge incisal occlusion (*Fig. 4*). The probable etiology of the anterior cross-bite was deemed to be palatal ectopic eruption of the maxillary central incisors. The deep curve of Spee in the lower arch and >100% overbite suggested a history of parafunction (*clenching*).

Fig. 4: Bilateral views of occlusion in centric relation (C_R)

Fig. 5:
Pre-treatment cephalometric and panoramic radiographs document the original dentofacial morphology. The panoramic film reveals that the upper canines are impacted and/or subject to high labial eruption.

Cephalometric and panoramic radiographs documented the dentofacial patterns before treatment (*Fig. 5*).

Skeletal:

- Class I malocclusion (*SNA 82˚, SNB 83.5˚, ANB -1.5˚ in centric occlusion* (C_O).
- Normal mandibular plane angle (*SN-MP 31˚, FMA 24˚*).

Dental:

- Molar relationship in CO: *Class I on both sides*
- Canine relationship: *Class II due to ectopic eruption of both upper canines*
- Negative overjet: *-3mm*
- Deep overbite: *8mm (>100%)*
- Crowding: *-9mm in the upper and -2mm in the lower arch*
- Third molars: *All four still developing*
- Midlines: *Lower dental midline coincident with the facial midline, upper dental midline was shifted to the left ~2mm of the facial midline*
- Arch forms: *Symmetrical square in the maxilla, V-shape in the mandible*

Facial:

- Profile: *Slightly concave*
- Lips: *Short upper lip, slightly protrusive lower lip*
- Vertical dimension of occlusion (*VDO*): *Decreased*

The ABO Discrepancy Index (*DI*) was 23 as shown in the subsequent worksheet.

Based on Lin's 3-ring diagnosis,[1] the patient was diagnosed as a Pseudo-Class III malocclusion, associated with anterior cross-bite and deep-bite in C_O.

Treatment Objectives

Maxilla (*all three planes*):

- A - P: *Allow for normal expression of growth*

- Vertical: *Allow for normal expression of growth*
- Transverse: *Expand to correct crowding and occlude with the lower arch*

Mandible (*all three planes*):

- A - P: *Maintain*
- Vertical: *Maintain*
- Transverse: *Maintain*

Maxillary Dentition:

- A - P: *Increase the axial inclination of the upper incisors*
- Vertical: *Maintain*
- Inter-molar / Inter-canine Width: *Expand to occlude with expanded lower dentition*

Mandibular Dentition:

- A - P: *Decrease by retracting the incisors*
- Vertical: *Decrease by intruding the incisors*
- Inter-molar / Inter-canine Width: *Expand to an ideal arch form*

Facial Esthetics:

- Retract the lower lip, and increase the maxillary incisor exposure

Treatment Plan

Traditional treatment approaches are extraction, headgear or rapid palatal expansion (*RPE*). However, careful evaluation of the malocclusion and its etiology indicated a conservative non-extraction treatment with a full fixed orthodontic appliance to align and level the arches, as well as to correct the anterior cross-bite and deep-bite.

Appliances and Treatment Progress

A 0.022-in slot passive self-ligating (*PSL*) bracket system (*Damon D3MX®, Ormco, Glendora, CA*) was bonded on the lower arch, with standard torque brackets in the anterior segment. All archwires, elastics and accessories were supplied by the same manufacturer. Bite turbos were constructed by bonding self-cured glass ionomer cement on the occlusal surface of both mandibular first molars (*Fig. 6*). The bite was opened ~8mm at the incisors to correct the anterior crossbite. The initial lower archwire was 0.014-in CuNiTi, fitted with resin balls that were bonded on the ends of the archwires to avoid mucosal irritation.

The upper PSL bracket was bonded a month later with low torque brackets on central incisors.[2] NiTi open coil springs opened the maxillary canine spaces. To avoid root resorption, it was important to avoid engaging the maxillary lateral incisors on the archwire, when the canines were moved past their roots (*Fig. 7*).[3]

Fig. 6:
Bite turbos are constructed on the occlusal surfaces of the lower first molars for the correction of the anterior crossbite.

After 3 months of active treatment, two drop-in hooks were fitted into the vertical slots of lower first premolars for an ELSE[4] (*Quail 3/16-in 2-oz*). The patient was instructed to use a wooden tongue depressor to correct the anterior crossbite. The maxillary canines erupted spontaneously as space was provided (*Fig. 8*).

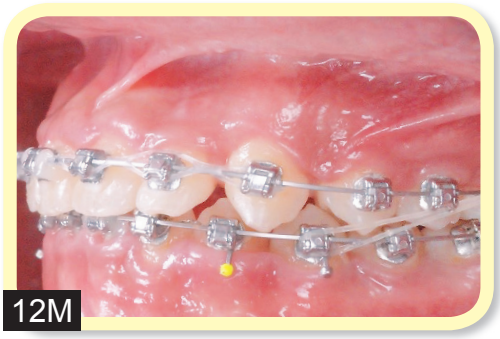
In the 7th month of treatment, brackets were bonded on the upper right (*UR*) and left (*UL*) canines, and the lower arch wire was changed to 0.018-in CuNiTi. Two months later, brackets were bonded on the UR and UL lateral incisors. The bite opening relative to the height of bite turbos was checked at every appointment to maintain the desired VDO. This maintenance is particularly important for patients prone to parafunction.

In the 11th month, the upper arch wire was changed to 0.014x0.025-in CuNiTi. There was an unexplained gumboil on the mucosa apical to the UR lateral incisor, but no other signs or symptoms of pathology. The following month, the lesion was gone, and there have been no further problems (*Fig. 9*). At the same appointment an 0.014x0.025-in CuNiTi lower arch wire was engaged.

In the 15th month, both archwires were changed to 0.017x0.025-in TMA. Two months later, a lingual

■ *Fig. 7:*
Open-coil springs were used for space creation and arch development.

■ *Fig. 8:*
Flowable resin was used to re-activate the open coil springs.



■ *Fig. 9:*
At eleven months (11M) a gumboil appeared of the root of the UL2 (yellow circle). One month later (12M) the unexplained gumboil disappeared.

button was bonded on each lower second molar and intermaxillary cross-elastics (*Chipmunk 1/8-in 3.5-oz*) were applied to correct the lingual inclination of the lower buccal segments.

In the 18th month, the anterior segments were ligated together with a stainless steel ligature, tied in a figure-eight pattern to maintain firm contact. The axial inclination of the lingually tipped mandibular second molars was corrected, so the bite turbos were removed. The upper arch wire was cut distal to the canines bilaterally, and intermaxillary elastics (*Kangaroo 3/16-in 4.5-oz*) were prescribed to settle the occlusion (*Fig. 10*).

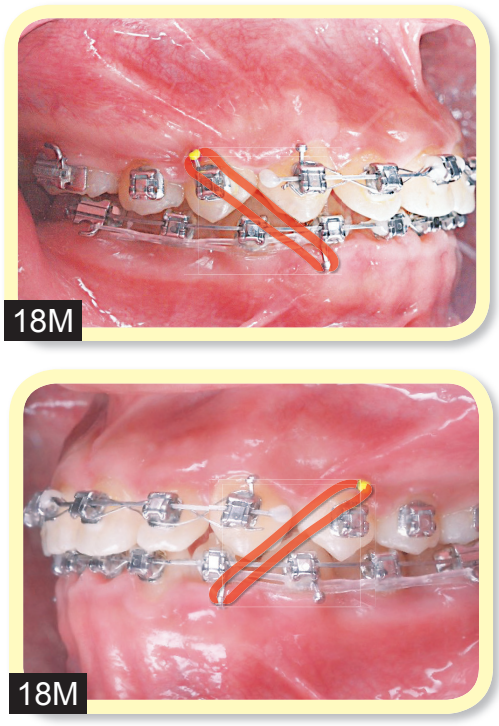


Fig. 10:
At eighteenth months (18M) the maxillary archwire was cut off distal to the canines, and the occlusion was settled with intermaxillary elastics.

After 20 months of active treatment, all fixed appliances were removed.

Results Achieved

As documented in Figs. 11-13, the patient was treated to the desired result, except for the ability to readily display his maxillary incisors when smiling. The cephalometric and panoramic radiographs before and after treatment are shown in Figs. 5 and 14, respectively. Superimposed cephalometric tracings are presented in Fig. 15, and a summary of cephalometric measurements is provided in Table 1.

Fig. 11:
Post-treatment facial photographs, after 20 months of active treatment.

Fig. 12: Post-treatment intra-oral photographs

Fig. 13: Post-treatment study models (casts)

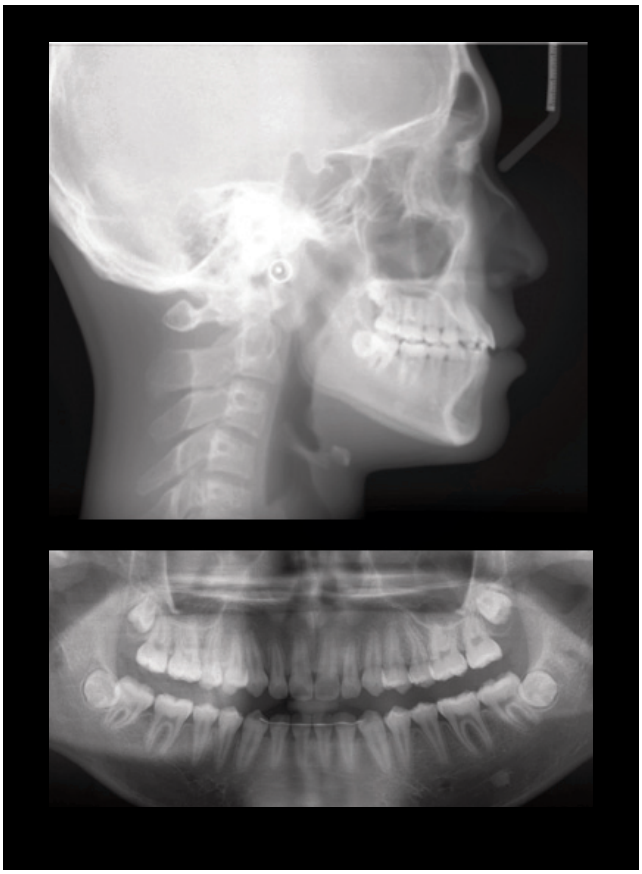


Fig. 14:
Post-treatment cephalometric and panoramic radiographs reveal the dentofacial morphology immediately after fixed appliances were removed.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	82°	85°	3°
SNB° (80°)	83.5°	84.5°	1°
ANB° (2°)	-1.5°	0.5°	2°
SN-MP° (32°)	31°	31°	0°
FMA° (25°)	24°	24°	0°
DENTAL ANALYSIS			
U1 TO NA mm *(4mm)*	2 mm	7 mm	5 mm
U1 TO SN° (104°)	98°	119°	21°
L1 TO NB mm *(4mm)*	4.5 mm	2 mm	2.5 mm
L1 TO MP° (90°)	79°	78°	1°
FACIAL ANALYSIS			
E-LINE UL *(-1mm)*	-2 mm	-1 mm	1 mm
E-LINE LL *(0mm)*	2.5 mm	1 mm	1.5 mm

Table 1: Cephalometric summary

Maxilla (*all three planes*):

- A - P: *Increased*
- Vertical: *Maintained*
- Transverse: *Maintained*

Mandible (*all three planes*):

- A - P: *Maintained*
- Vertical: *Maintained*
- Transverse: *Increased*

Maxillary Dentition:

- A - P: *Alveolar process was protracted as the incisors were tipped labially*
- Vertical: *Maintained*

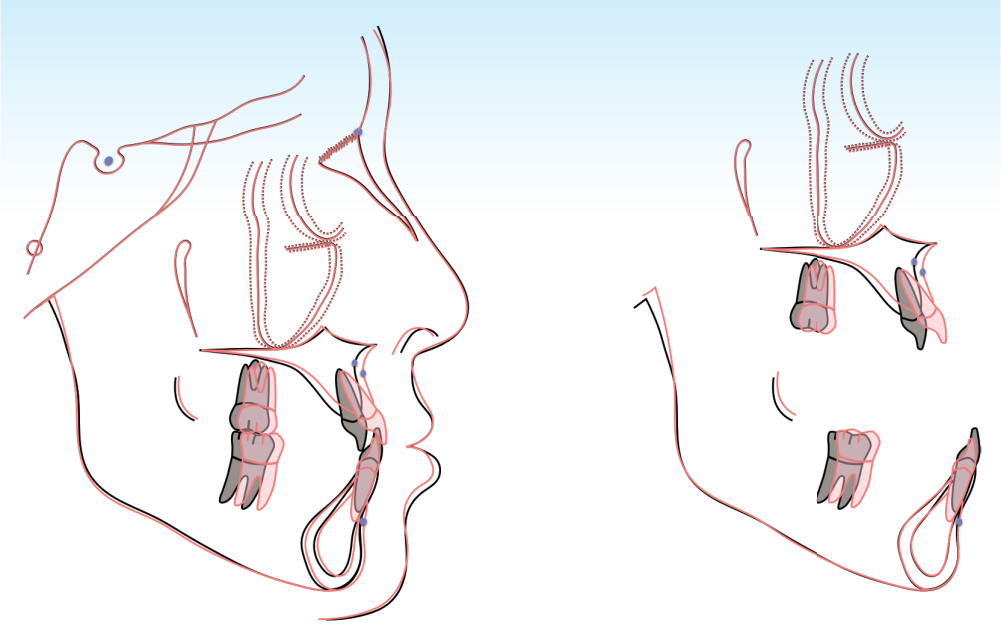


Fig. 15:
Pre- (black) and post- (red) treatment cephalometric tracings are superimposed on the anterior cranial base (left), the maxilla (upper right), and the stable internal structures of the mandible (lower right). Principal changes during treatment were protraction of the maxillary process, labial tipping of the incisors, and decreased lower lip protrusion.

- Inter-molar / Inter-canine Width: *Maintained*

Mandibular Dentition

- A - P: *Alveolar process retracted as incisors are tipped lingually*
- Vertical: *Maintained*
- Inter-molar / Inter-canine Width: *Expanded*

Facial Esthetics: Protrusive lower lip retracted

Superimpositions: The lower incisors and the protrusive lips were retracted.

This challenging malocclusion (*DI=23*) (*Worksheet 1*), was treated in 20 months to an ABO Cast-Radiograph Evaluation (*CRE*) score of 23 points (*Worksheet 2*). The major residual CRE discrepancies were buccolingual inclination of the posterior teeth (*5 points*), marginal ridges (*4 points*), and occlusal contacts (*4 points*).

Overall, there was significant improvement in both dental esthetics and occlusion. The profile was treated to an appropriate result with no esthetic problems. The only significant concern was the flaring and relative intrusion of the maxillary central incisors, as they were tipped labially. This side effect of treatment resulted in inadequate incisal exposure when smiling and an unfavorable Pink & White dental esthetic score of 6 (*Worksheet 3*).

Retention

An anterior fixed retainer was bonded on the lingual surfaces of the lower dentition from canine to canine. Removable clear overlay retainers were delivered for both arches, and the patient was instructed to wear them full time for the first 6 months and nights only thereafter. Instructions were provided for home hygiene, as well as for maintenance of the retainers.

Discussion

Pseudo-Class III malocclusion is usually much easier to manage than a skeletal Class III discrepancy. An accurate diagnosis is essential for devising an appropriate treatment plan. The Lin 3-Ring Diagnosis (*Fig. 16*) is an effective method for differential diagnosis.[5] There are three critical considerations:

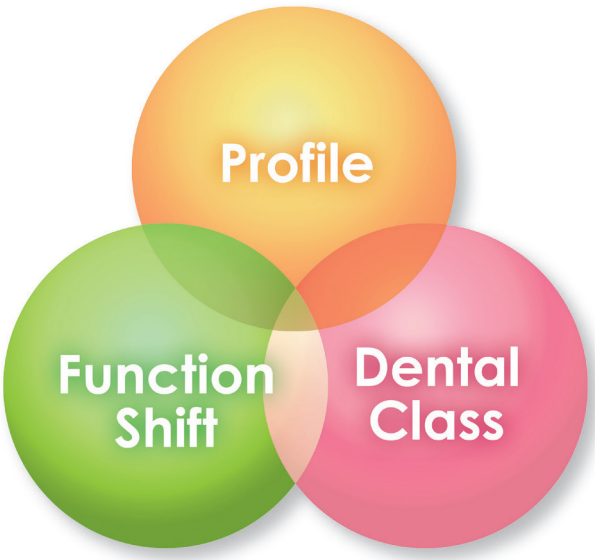


Fig. 16:
The 3-ring diagnosis scheme introduced by John Lin.

Profile in Central Relation (C_R): If the facial profile is orthognathic, or at least acceptable in the C_R position, the patient is a good candidate for conservative dentoalveolar treatment. Patients with a severely prognathic mandible and concave profile in C_R, usually require orthognathic surgery or extra-alveolar bone screw anchorage.[6,7]

Class: Evaluate the sagittal position of the canines and first molars in centric occlusion (C_O). An anterior cross-bite is more readily resolved when the molars are Class I in C_O (*pseudo Class III*) compared to Class III in C_O (*true skeletal Class III*).[6,7]

Functional Shift: The presence or absence of a functional shift from $C_R \rightarrow C_O$ is an essential aspect of the diagnosis. Class III patients with a functional shift (*pseudo-Class III*) have an improved prognosis for conservative treatment, that is proportional to the magnitude of the shift.

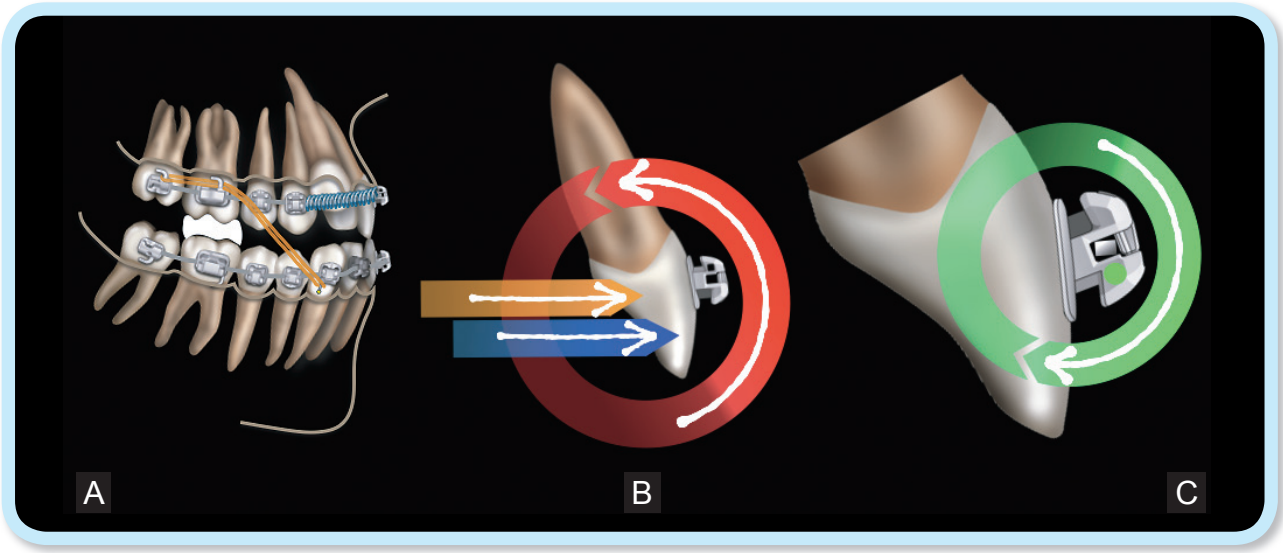
Many treatment approaches are reported for orthopedic and orthodontic treatment of skeletal class III malocclusion: RPE with extra-oral face mask (*FM*) protraction device,[8] functional regulator-3 appliance of Frankel,[9] removable mandibular retractor,[10] chincup,[11] Class III elastics with a chincup,[12] RPE,[13] and mandibular cervical headgear.[14,15] RPE combined with FM therapy is the most common treatment for skeletal Class III malocclusion, but recent reports document an ideal resolution of severe skeletal Class III malocclusions with extra-alveolar bone screw anchorage.[6,7] A recent review of 23 skeletal Class III patients treated in this

manner demonstrates that even Class III open bite patients can be managed conservatively, i.e. without orthognathic surgery.[6]

On the other hand, a patient with pseudo-class III malocclusion[16,17] (*Fig. 16*) has an excellent prognosis for a relatively simple dentoalveolar correction if the following conditions are met: functional shift, Class I in C_R, and an acceptable profile. Fortunately, uncomfortable appliances like RPE and FM are unnecessary. Most pseudo-Class III patients can be effectively managed without extractions, bone screws or orthognathic surgery, but these mechanics can result in excessive flaring of the upper incisors (*Fig. 17*).

For the present patient, the major mechanics were bite turbos on the lower first molars, Class III elastics, upper incisor tipping to the labial, space opening for the maxillary canines, and expansion of the lower arch (*Figs. 17-20*). The patient appeared to have a parafunctional habit (*clenching*), which caused attrition and periodic fractures of the bite turbos. Furthermore, the clenching prevented opening the VDO (*Figs. 14 and 15*), so the space opening mechanics and Class III elastics excessively tipped the upper incisors labially (*Fig. 17*).

In retrospect, it would have been wise to use brackets with more negative torque in the maxillary anterior region to control tipping (*Fig. 17*). Also, placing the bite turbos on the premolars would have permitted molar extrusion to open the bite, thereby relieving some of the tendency for the upper



■ *Fig. 17:*
A: Open coil springs, glass ionomer cement type II, and Class III elastics were used to correct the anterior cross-bite and crowding. B: Both the forces of elastic (orange arrow) and open coil spring (blue arrow) increase the labial crown torque (red circle) on upper incisors. C: When the rectangular arch wire is engaged in low torque bracket, it creates lingual crown torque (green arrow) to compensate the side effect of Class III elastics and open coil springs.

incisors to flare. Despite the clenching problems, the simple methods described managed the pseudo-Class III malocclusion with a constricted mandibular arch in only 20 months. Effective treatment of pseudo-Class III malocclusion requires an accurate diagnosis, and frequent monitoring of progress to ensure that adequate bite opening limits the excessive flaring and relative intrusion of the maxillary incisors.

Fig. 18:
Intraoral frontal views of the treatment sequence are shown in clockwise order from pretreatment in the upper (0M) to post-treatment in the lower left (20M). The months (M) of treatment are shown in the black box in the lower right corner of each photograph. The correction of anterior cross-bite was achieved in 11 months.

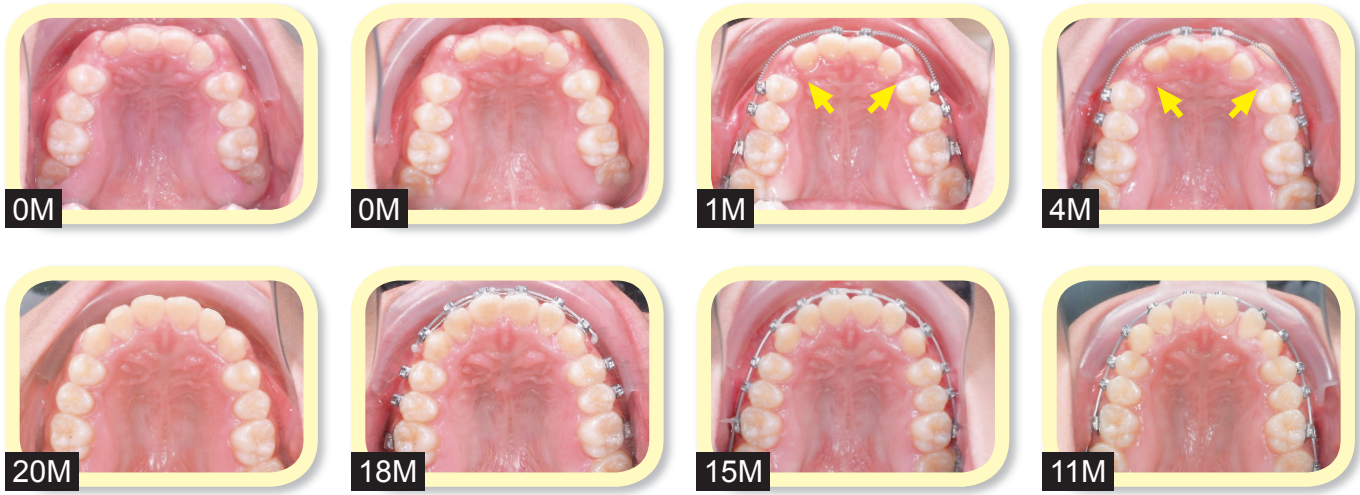


Fig. 19:
Maxillary occlusal views of the treatment sequence show the arch length was increased, and space was created by using open coil springs (yellow arrows).

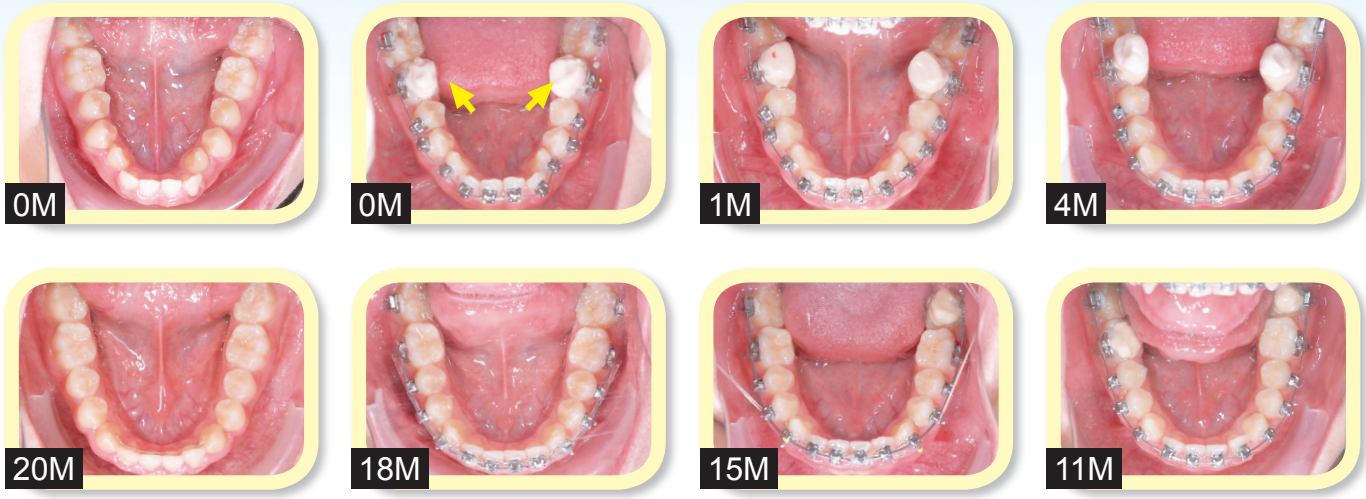


Fig. 20:
Mandibular occlusal views of the treatment sequence show that bite turbos made of glass ionomer cement (arrows) and Class III elastic were used to correct the anterior crossbite. Note the arch development as the arch width was increased, and the inclination of posterior teeth was corrected.

A Hawley bite-plate can be used to extrude the molars, open the bite, and retract the maxillary incisors, if adequate space is available. If no interproximal space is present, differential enamel stripping is indicted. For the present patient, nocturnal parafunction (*clenching*) may continue to contribute to flaring of the maxillary incisors after treatment. Parafunction during the sleeping hours is best managed with a Hawley bite-plate prepared with a premature occlusal stop for the lower incisors, that prevents the molars from contacting (*Fig. 21 and 22*).[17] When worn only at night, this appliance is a long-term neurologic orthotic because it utilizes a polysynaptic reflex to inhibit the firing of the motor nucleus of cranial nerve V (*masseteric silent period*).[18-21]

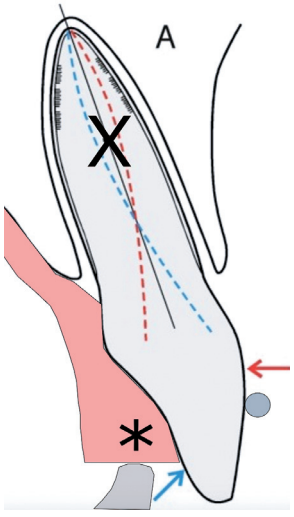


Fig. 21:
A schematic drawing shows a cut-away view of a Hawley biteplate. The acrylic bite-plate (pink) creates an occlusal stop (*) for the lower incisor. Incisal flaring is presented by the labial wire, gray circle in cross-section. The stabilization of the bite-plate prevents (X) the root flexure (dotted red and blue lines), due to an occlusal prematurity (blue arrow) combined with the retracting force (red arrow) due to an orthodontic appliance. Drawing adapted from Roberts, reference 17.

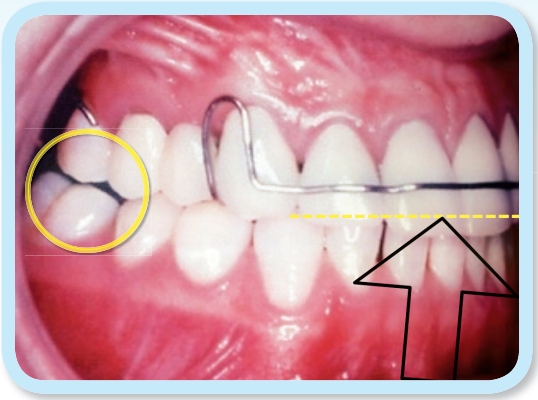


Fig. 22:
An intraoral photograph of a Hawley bite-plate is a clinical view of the appliance constructed as shown in Fig. 21. Note that the path of the lower incisors on closing (arrow) strikes the bite-plate (yellow dotted line). This premature contact of the lower incisors on the bite-plate prevents the molars from contacting (yellow circle). If worn continuously, this appliance will result in extrusion of the molars to open the bite. With nights only wear, this appliance becomes a neurologic orthotic that prevents occlusal damage due to parafunction, by inhibiting the contraction of the mandibular elevator muscles. See text for details. Illustration adapted from Roberts, reference 17.

Conclusion

1. Diagnosis is the key to the successful management of an anterior crossbite. Use the 3-ring diagnosis to distinguish pseudo from true Class III anterior cross-bite.

2. Anterior crossbite is usually a pseudo Class III malocclusion if there is a functional shift of the mandible to achieve maximal intercuspation.

3. Keep the treatment as simple as possible to achieve the patient's objectives.

4. Manage clenching as needed if bite opening is indicated.

Acknowledgment

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 23

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 = 7

Total = 7

OVERBITE

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

Total = 5

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 = 7

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. additional _____ pts.

Total = 0

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° _____ x 1 pt. = _____

Each degree > 6° _____ x 1 pt. = _____

SN-MP

≥ 38° = 2 pts.

Each degree > 38° _____ x 2 pts. = _____

≤ 26° = 1 pt.

Each degree < 26° _____ x 1 pt. = _____

1 to MP ≥ 99° = 1 pt.

Each degree > 99° _____ x 1 pt. = _____

Total = 0

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)	_____ x 1 pts. =	_____
Missing teeth, congenital	_____ x 2 pts. =	_____
Spacing (4 or more, per arch)	_____ x 2 pts. =	_____
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:
ectopic eruption of maxillary canines

Total = 4

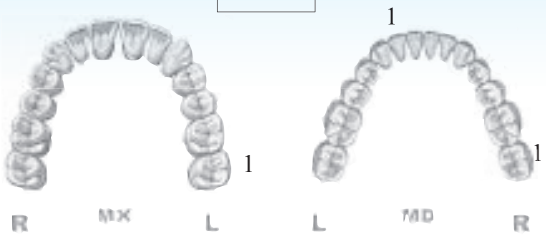
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 23

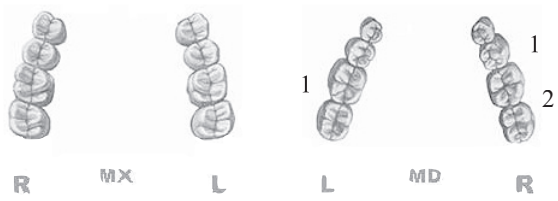
Alignment/Rotations

3



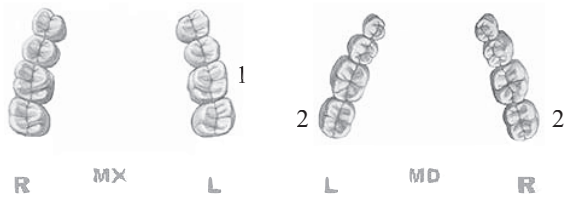
Marginal Ridges

4



Buccolingual Inclination

5

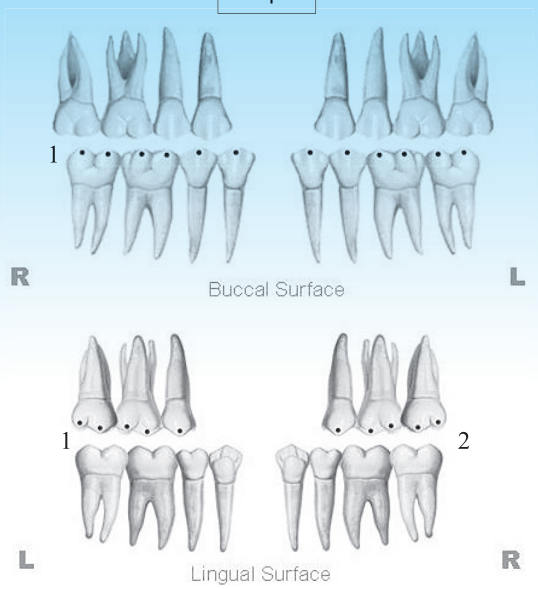


Overjet

3

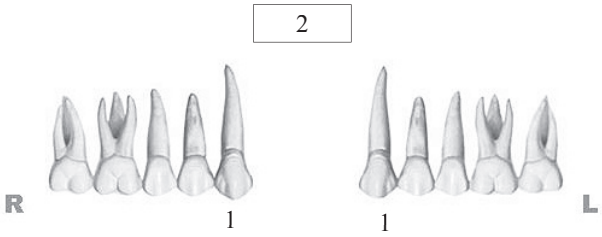
Occlusal Contacts

4



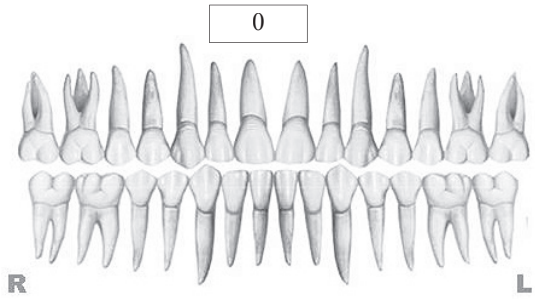
Occlusal Relationships

2



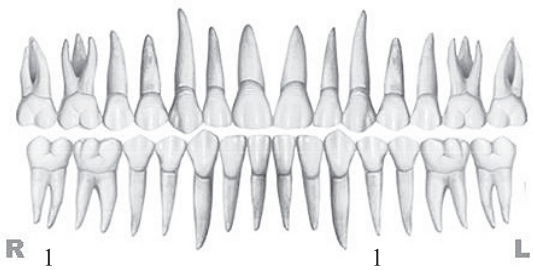
Interproximal Contacts

0



Root Angulation

2



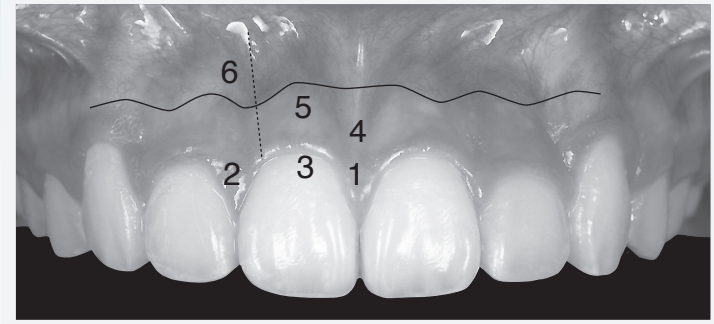
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 6

1. Pink Esthetic Score

Total = 2

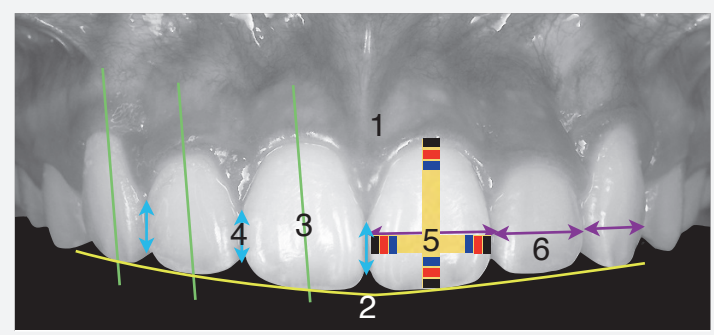


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

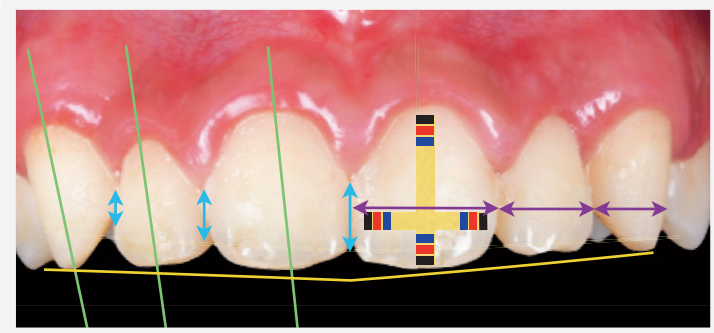
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	0	(1)	2
4. Level of Gingival Margin	0	(1)	2
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 4



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