Skeletal Class III Malocclusion with Canine Transposition and Facial Asymmetry

History and Etiology

A 13-year-6-month-old male presented with a chief complaint of prognathic mandible (*Figs. 1-3*). There was no other contributory medical or dental history. The etiology was hereditary tendency for prognathic mandible with eruption of the maxillary central incisors into crossbite, which resulted in a functional shift of 4mm anterior and 3mm to the left. Clinical exam indicated transposition of the permanent right maxillary canine and premolar, general crowding and anterior crossbite (*Fig. 2*). Extraction of all four first premolars was proposed to correct the canine transposition and create space for retraction of lower anterior dentition. The patient was treated to an acceptable result as documented in Figs. 4-9.

Diagnosis

In centric occlusion, a severe dental asymmetry was noted: Class III molar on the right side, Class I molar on the left side, and an intermaxillary midline discrepancy of ~7mm. There was a concave profile and asymmetrical facial form with the mandible deviated to the left. Relative to the facial midline, the upper dental midline was 2 mm to the right, while the lower dental midline was 5 mm to the left. The

anterior crossbite extended from the right lateral incisor to the left 2nd premolar. Cephalometric and panoramic radiographs (*Fig. 7*), as well as anterior segment photographs (*Fig. 10*) document the complexity of the malocclusion.

Skeletal:

- Skeletal Class III (SNA 70°, SNB 75°, ANB -5°)
- Mandibular plane angle (SN-MP 37°, FMA 29°)

Dental:

- Functional shift 4mm anteriorly and 3mm to the left
- Class III on the right and Class I molar relationship on the left.
- Maximum overbite 3 mm
- Maximum overjet -3 mm
- Severe crowding of ~10 mm in the upper arch and 7 mm in the lower arch
- Right maxillary canine blocked-out and transposed with the adjacent 1st premolar

The ABO Discrepancy Index (DI) was 46 points as shown in the subsequent worksheet.

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Fig. 1: Pre-treatment facial photographs



Fig. 4: Post-treatment facial photographs



Fig. 2: Pre-treatment intraoral photographs



Fig. 5: Post-treatment intraoral photographs



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



Fig. 6: Post-treatment study models (casts) reveal modest expansion in both arches.



Fig. 7: Pre-treatment panoramic and cephalometric radiographs

Fig. 8: Post-treatment panoramic and cephalometric radiographs



Fig. 9:

Superimposed tracings. Reasonable mesial drift of molars and retraction of incisors were found in this extraction case. Overjet correction due to maxillary incisors uprighting. Well controlled torque of the lower incisors were noticed.



Fig. 10: Close-up views of the right maxillary canine-premolar transposition and canting of the lower occlusal plane.

Specific Objectives of Treatment

Maxilla (all three planes):

- A P: Maintain
- Vertical: Maintain
- Transverse: Expand to coordinate with lower arch

Mandible (all three planes):

- A P: Maintain
- Vertical: Posterior rotation to open the vertical dimension of occlusion
- Transverse: Maintain

Maxillary Dentition:

- A P: Maintain
- Vertical: Extrusion of molars
- Inter-molar Width: Maintain

Mandibular Dentition:

- A P: Retraction of anterior teeth
- Vertical: Extrusion with increased vertical dimension of occlusion
- Inter-molar / Inter-canine Width: Maintain

Facial Esthetics:

• Posterior movement of chin point and lower lip

Treatment Plan

All four 1st premolars were extracted to create space to align the transposed right maxillary canine, as well as to retract the protruded lower anterior segment, to correct the crossbite (*Fig. 11*). Anterior bite turbos were bonded on the lingual surfaces of the mandibular central incisors and the left lateral incisor to open the bite for crossbite correction. Early light short Class III elastics were used in the initial stage of treatment to assist crossbite correction (*Fig. 12*).

After the crossbite correction and alignment of the maxillary anterior segment, a torquing auxiliary was indicated for the maxillary right canine. A mandibular pre-torqued rectangular NiTi wire, with vertical elastics were used to flatten and align the arch (*Fig. 13*). A mandibular anterior torquing auxiliary and asymmetric intermaxillary elastics (*Class III right, Class II left*) were applied (*Figs. 14-15*). Vertical elastics were used to produce the final occlusion (*Fig. 16*). The fixed appliances were removed and the



Fig. 11:

Premolars were extracted in the initial treatment. Anterior bite turbos were boned on the lower arch for bite opening.



Fig. 12:

Class III elastic provided horizontal and vertical forces to improve canting in the lower arch and to facilitate early correction of Class III relation.

CEPHALOMETRIC					
SKELETAL ANALYSIS					
	PRE-Tx	POST-Tx	DIFF.		
SNA°	70°	70°	0°		
SNB°	75°	73.5°	1.5°		
ANB°	-5°	-3.5°	1.5°		
SN-MP°	37°	42°	5°		
FMA°	29°	34°	5°		
DENTAL ANALYSIS					
U1 TO NAmm	9 mm	11 mm	2 mm		
U1 TO SN°	116°	120°	4°		
L1 TO NBmm	6 mm	4.5 mm	1.5 mm		
L1 TO MP°	89°	87.5°	1.5°		
FACIAL ANALYSIS					
E-LINE UL	-2 mm	-1 mm	1 mm		
E-LINE LL	2.5 mm	2 mm	0.5 mm		

Table 1: Cephalometric summary

corrected dentition was retained with fixed anterior retainers (*Mx 3-3, Md 5-5*) that were bonded to each tooth in both arches (*Fig. 5*).

Appliances and Treatment Progress

A .022" Damon Q[®] bracket system (*Ormco*) was used. The maxillary arch was bonded with standard torque brackets, and low torque brackets reversed were selected for the lower anterior teeth to counter the force of Class III elastics (*Fig. 12*).

After seven months of active treatment, the right maxillary canine was aligned into the arch. Positive overjet was achieved and the canting of the lower occlusal-plane (*Fig. 10*) was improved (*Fig. 13*). Anterior



🔳 Fig. 13:

7th month of treatment. leveling of right maxillary canine and the lower-occlusal plane canting were improved. Positive overjet was also achieved.

root torque springs (*ART*) were placed on both the lower anterior teeth and right maxillary canine for early torque control (*Figs. 13-14*). After eleven months of active treatment, maxillary space was closed, but the excessive Curve of Spee of the lower arch and the midline deviation were still evident. Clockwise rotation of the mandible corrected the severe Class III relationship on the right side to Class I, but the slight Class III on the left evolved into a Class II molar relationship. A .016x.025" pre-torqued NiTi wire with asymmetrical elastics were used to flatten the Curve of Spee and correct the molar relationship in this stage of treatment (*Fig. 14*).



 Fig. 14: Asymmetrical elastics and a pre-torque NiTi wire were introduced in the 11th month of treatment. (Arrow: lower 3-3 ART)

From the 12-20 months of treatment, a Class III L-shape elastic from the right mandibular canine, and coursing under the 2ndpremolar bracket to the right maxillary 1st molar was used for space closure and settling of the posterior occlusion (*Fig. 15*). Seven months were required to correct the asymmetric molar relationships.

In the last two months of treatment, elastics were applied to settle the occlusion: upside down U shape elastics in the anterior and a vertical elastics in the second molar area bilaterally were applied to settle the final occlusion (*Fig. 16*). After 29 months of active treatment, all appliances were removed.



Fig. 15:

A L-shape Class III vector elastic was utilized for space closure, settling posterior bite and better interdigitation.





Fig. 16:

Elastics used at the end of treatment to settle occlusion.

Results Achieved

Maxilla (all three planes):

- A P: Maintained
- Vertical: Maintained
- Transverse: Maintained

Mandible (all three planes):

- A P: Retracted
- Vertical: Mild clockwise rotation to increase the vertical dimension
- Transverse: Maintained

Maxillary Dentition:

- A P: Flaring of the incisors
- Vertical: Molar extrusion and mesial movement
- Inter-molar / Inter-canine Width: Maintained

Mandibular Dentition:

- A P: Flaring of the incisors
- Vertical: Molar extrusion and mesial movement
- Inter-molar / Inter-canine Width: Maintained

Facial Esthetics:

· Retraction of the lower lip and chin point

Retention

Fixed retainers were bonded on all maxillary incisors and from second premolar to second premolar in the mandibular arch. An upper clear overlay retainer was delivered. The patient was instructed to wear it full time for the first 6 months and nights only thereafter. Instructions in home care and maintenance of retainers were provided.

Final Evaluation of Treatment

The ABO Cast-Radiograph Evaluation score was 22 points. The major discrepancies were in the lingual occlusal contacts and alignment/rotation. Deviation of the lower dental midline was decreased to 1 mm to the left of the maxillary midline. The transposed canine was well aligned, and the gingiva texture was healthy (*Fig. 5*).

Collectively, molar extrusion and mandible clockwise rotation improved the facial profile. The Class III molar relation was corrected. Overall, this Class III asymmetric malocclusion was treated to an appropriate facial and dental result. The roots of the maxillary incisors were out of focus on the posttreatment panoramic radiograph, but it appears that there was significant root resorption of both maxillary central incisors and the left lateral incisor. The latter may have been due to the occlusal stress of the premature contact with the anterior bite turbos during crossbite correction.

Discussion

Surgical correction is routinely indicated for asymmetrical Class III malocclusions because of a questionable prognosis for orthodontics only management of large skeletal discrepancies and unsatisfactory esthetic outcomes.¹ However, if there is a substantial functional shift, the asymmetrical profile and mandibular shift are accentuated.² Increasing lower facial height and correcting the functional shift are more readily achieved with nonsurgical treatment. Carefully considering the pros and cons of conventional and surgical treatment are important elements of diagnosis and treatment planning.

Growth potential warrants additional consideration if a patient exhibits signs of mandibular overgrowth. In the present case, although the mandibular prognathism was noted at the beginning of treatment, little or no further increase in mandibular length was noted during treatment. Baccetti³ provided an assessment method for determining skeletal maturation by evaluating the cervical vertebrae in routine lateral cephalograms. For the present case, skeletal maturation exceeded CS 5, indicating a mature skeletal pattern, suitable for treatment as an adult. There were additional indicators favoring non-surgical orthodontic options: 1) the chief complaint was mandibular prognathism without consideration of facial asymmetry, 2) reduced lower facial height, 3) obtuse nasolabial angle, 4) negative overjet less than 4mm,⁴ and 5) a moderate Class III molar relationship with a discrepancy that was less than a molar's width.⁵

A conservative treatment approach was selected which consisted of a camouflage dental correction (*Fig. 17*) with counter-clockwise rotation of occlusal



Fig. 17: Camouflage dental correction with counter-clockwise rotation of the occlusal plane.

plane. Downward and backward rotation of the chin point, in conjunction with molar extrusion and increased lower facial height, produced a more harmonious lateral facial profile. Predictable dental changes included proclination of the maxillary incisors and retroclination of the mandibular incisors. Torque control was essential in camouflage treatment in order to prevent further periodontal problems. Lost control of anterior teeth might compromise long-term stability, particularly in extraction cases.⁶ Early usage of ARTs and the pretorqued NiTi wire on the lower arch delivered a continuous light force, as opposed to a heavy interruptive force from a twisted rectangular wire at a later stage in treatment. As the transposed right maxillary canine was moved mesially, an ART spring was used to correct the axial inclination (*Fig. 18*). Higher torque canine brackets would have been more favorable for the present case (*Fig. 12*).

Anterior or posterior placement of bite turbos can be used for bite opening. For the present patient, molar extrusion and clockwise rotation of the mandible were part of the treatment plan, so anterior bite turbos were appropriate for this purpose. With bite turbos and early light short elastics (*Class III vector*), the anterior crossbite was corrected within seven months. Short Class III



Fig. 18:

Early torque control in right maxillary canine contributed good torque express in the middle of treatment. (Arrow: root torque spring)

elastics on the right side also provided an extrusion force for the infra-occlusion right mandibular canine and redirected the displaced mandible to return to its normal position. This approach would not be appropriate for patients with a true severe skeletal asymmetry and large discrepancy in ramus height. Carefully monitoring of the treatment response is critical for success. For instance, incisal occlusal stress due to anterior bite turbos may contribute to the root resorption of the maxillary incisors in some patients. A progress radiograph six months into treatment would have been appropriate because the root of the left maxillary central incisor appears to be moderately resorbed prior to treatment (Fig. 7). Fortunately, the panoramic radiograph at the end of treatment showed no significant progression of maxillary incisal root resorption (Fig. 8).

Temporary anchorage devices (TADs), placed lateral to the alveolar processes (mandibular buccal shelves, infrazygomatic crests) are a break-through for

treatment of Class III malocclusions.^{5,7} The stationary anchorage of TADs facilitate retraction of the entire lower arch, without proclination (anterior tipping) of maxillary incisors⁷ or deterioration of smile arc, two common problems with Class III elastics (Fig. 19).^{5,8} For many Asians, the major contributory factor for Class III malocclusion is mandibular prognathism with normal mid-face development.⁹ TADs provide reliable anchorage for Class III treatment without creating the undesirable effects seen with intermaxillary elastics. For the present patient, the application of TADs was considered, but discarded because of the acceptable upper lip prominence (Fig. 20), and the transposition of the maxillary right canine and first premolar. Nonextraction treatment of the transposition with TAD anchorage would have been very difficult. Since extraction of the maxillary left first premolar was necessary, the most expedient approach was to remove all four first premolars, and treat the patient with conventional mechanics.



Fig. 19:

Flattening of smile arc after Class III correction is a common side effect in traditional interarch Class III mechanics.

As mentioned previously, smile arc preservation is crucial for an esthetic result with Class III cases.¹⁰ Ackerman reported that 40% of routine orthodontics corrections show a deterioration in smile arc.¹¹ The nature of Class III mechanics include molar extrusion, counter-clockwise rotation of the occlusal plane⁸ (Fig. 17), and torque change in incisors of both arches. These side effects further challenge smile arc preservation during Class III (Fig. 19) treatment. Restrictive usage of Class III elastics, in combination with Class II elastics and TADs in the mandible, can effectively enhance the smile arc.⁷ However, the biomechanical boundary remains definitive, regardless of the treatment methods.¹² As proposed by Kondo,^{13, 14} the anterior limit for incisor retraction is the posterior border of the symphysis, while the PM or ramus line is the posterior limit for arch retraction (Fig. 21).

Asymmetrical correction is complex, and often involves various mechanics, including intra-arch

auxiliaries¹⁵ and multiple loops, for realigning and coordinating the arch.¹⁶ These special mechanics are often associated with undesirable side effects like compromised molar angulation to meet occlusal goals at the end of treatment.¹⁷ Low fiction, selfligating brackets with special elastics configurations simplify this challenge significantly. Although the 4mm midline deviation, that was evident after correction of the functional shift, was not completely corrected for the present patient, but the result was satisfactory. The CRE score was 22, with most of the points deducted for inadequate third order correction of the maxillary posterior segments, which is reflected in the scores for buccolingual inclination (4 points) and lingual cusp contacts (3 *points*). More buccal root torque in the maxillary buccal segments and additional detailing with wire bending in the finishing stage would have improved the final result.¹⁸



 Fig. 20: An acceptable upper lip profile without TADs anchorage.



 Fig. 21: Anterior and posterior boundary of the whole arch distalization in the mandible.

Conclusion

Skeletal Class III treatment with camouflage orthodontics presents significant clinical challenges. The treatment is further complicated with Asian patients who present with hereditary etiology and severe crowding. Orthopedic treatment with rapid maxillary expansion, a facemask or a chincap show varying degrees of success, due to different protocols and case selection.^{19, 20} With the help of self-ligating brackets, bite turbos, and a properly designed force system, clinicians can now deliver relatively efficient extraction treatment that achieves a satisfactory result. However, the progress of treatment should be carefully monitored to control potential complications.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE

46

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 =



ANTERIOR OPEN BITE

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

Total



LATERAL OPEN BITE

2 pts. per mm. per tooth

Total



7

4

CROWDING (only one arch)

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

OCCLUSION

Class I to end on	=	0 pts.
End on Class II or III	=	2 pts. per sidepts.
Full Class II or III	=	4 pts. per sidepts.
Beyond Class II or III	=	1 pt. per mm. <u>pts.</u>
		additional

=

Total

LINC	GUAL PO	<u>)STERIO</u>	R X-B	ITE	

1 pt. per tooth	Total	=		2
BUCCAL POSTERI	OR X-E	<u>BITE</u>		
2 pts. per tooth	Total	=		2
CEPHALOMETRIC	<u>CS</u> (Se	ee Instruct	ions)	
ANB $\geq 6^{\circ}$ or $\leq -2^{\circ}$			=	4 pts.
Each degree $< -2^{\circ}$	3	_x 1 pt.	=	3
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°			=	1 pt.
Each degree $> 99^{\circ}$		x 1 pt.	=	

OTHER (See Instructions)

Supernumerary teeth		_x 1 pt. =		
Ankylosis of perm. teeth		x 2 pts. =		
Anomalous morphology		x 2 pts. =		
Impaction (except 3 rd molars)		x 2 pts. =		
Midline discrepancy (\geq 3mm)		@ 2 pts. =	2	
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 \geq 2mm)		(a) 2 pts. =		
Tooth transposition	1	x 2 pts. =	2	
Skeletal asymmetry (nonsurgical tx)		a_{0}^{2} 3 pts. =	3	
Addl. treatment complexities		x^2 pts. =		
1				

Total

Identify:

Total

7

=

7

=



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: =

5

1. Pink Esthetic Score





2. White Esthetic Score (for Micro-esthetics)





1. Mesial Papilla	0	1	2
2. Distal Papilla	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

Total =

2

Total =

3

1. Midline 0 1 2 2. Incisor Curve 1 2 0 3. Axial Inclination (5°, 8°, 10°) 2 0 1 4. Contact Area (50%, 40%, 30%) 0 1 2 5. Tooth Proportion (1:0.8) 0 1 2 6. Tooth to Tooth Proportion 2 0 1 1. Midline 0(1)2 2. Incisor Curve 0(1)23. Axial Inclination (5°, 8°, 10°) 0(1)24. Contact Area (50%, 40%, 30%) (0) 1 2 5. Tooth Proportion (1:0.8) (0)1 2 (0) 1 2 6. Tooth to Tooth Proportion