



# Class I Crowding with Canine Transposition and Midline Deviation

## History and Etiology

A 18-year-11-month-old male presented with a chief complaint of “*crooked teeth*,” an apparent reference to his asymmetric anterior malocclusion (Figs. 1-3). There was no other contributory medical or dental history. Clinical exam revealed transposition of the permanent right maxillary canine and adjacent premolar. In addition, generalized crowding was noted in both arches (Fig. 2). Extraction of all four first permanent premolars was indicated, to relieve crowding in both arches and correct the canine-premolar transposition. The patient was treated to an acceptable result as documented in Figs. 4-9. Detailed diagnosis, treatment procedures and recommended follow-up will be discussed below.

## Diagnosis

The patient presented with a convex facial profile and a bilateral class I molar relationship. The maxillary dental midline was shifted 2 mm to the right of the facial midline, and there was a lingual cross-bite of the right maxillary lateral incisor. Cephalometric and panoramic radiographs (Fig. 7) document the complexity of the malocclusion (Fig. 10).

### Skeletal:

- Skeletal Class I (SNA 75°, SNB 74°, ANB 1°)



■ Fig. 1: Pretreatment facial photographs

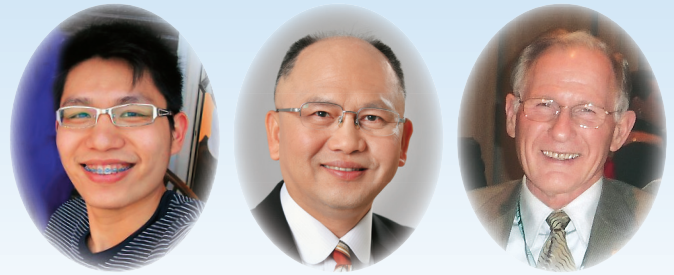


■ Fig. 2: Pretreatment intraoral photographs



■ Fig. 3: Pretreatment study models

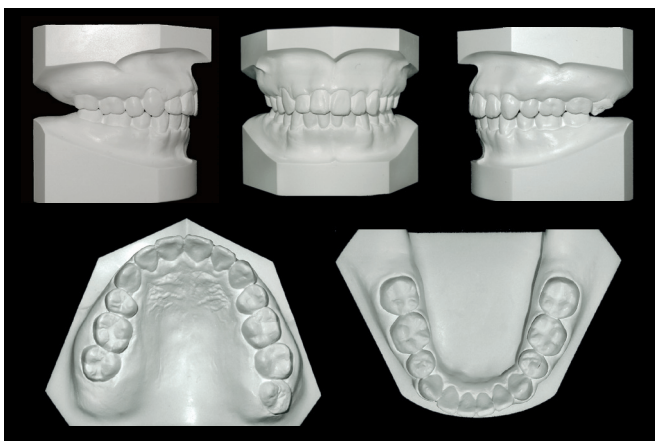
Dr. Wei Ming-Wei, Lecturer,  
Beethoven Orthodontic Center (left)  
Dr. Chris HN Chang, Director,  
Beethoven Orthodontic Center (middle)  
Dr. W. Eugene Roberts, Consultant,  
*International Journal of Orthodontics & Implantology* (Right)



■ Fig. 4: Posttreatment facial photographs



■ Fig. 5: Posttreatment intraoral photographs



■ Fig. 6: Posttreatment study models

- Mandibular plane angle ( $SN-MP$   $35^\circ$ ,  $FMA$   $28^\circ$ )

Dental:

- Bilateral Class I crowded malocclusion
- overbite: 3.5 mm
- overjet: 3 mm
- Severe crowding of about 10 mm in the upper arch and 9 mm in the lower arch

The ABO Discrepancy Index (*DI*) was scored at 15 points as shown in the subsequent worksheet.

Specific Objectives of Treatment

Maxilla (*all three planes*):

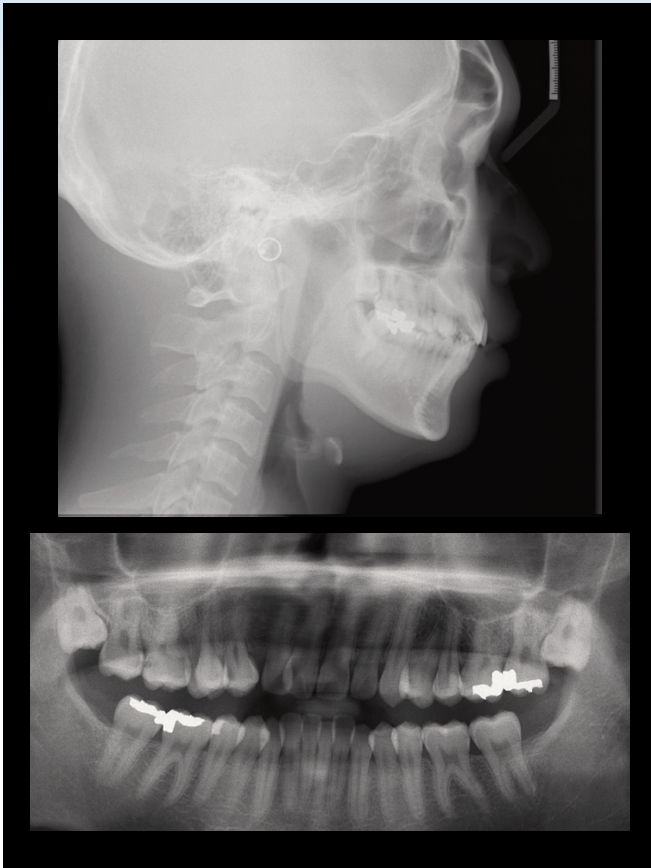
- A - P: Maintain
- Vertical: Maintain
- Transverse: Maintain

Mandible (*all three planes*):

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

Maxillary Dentition

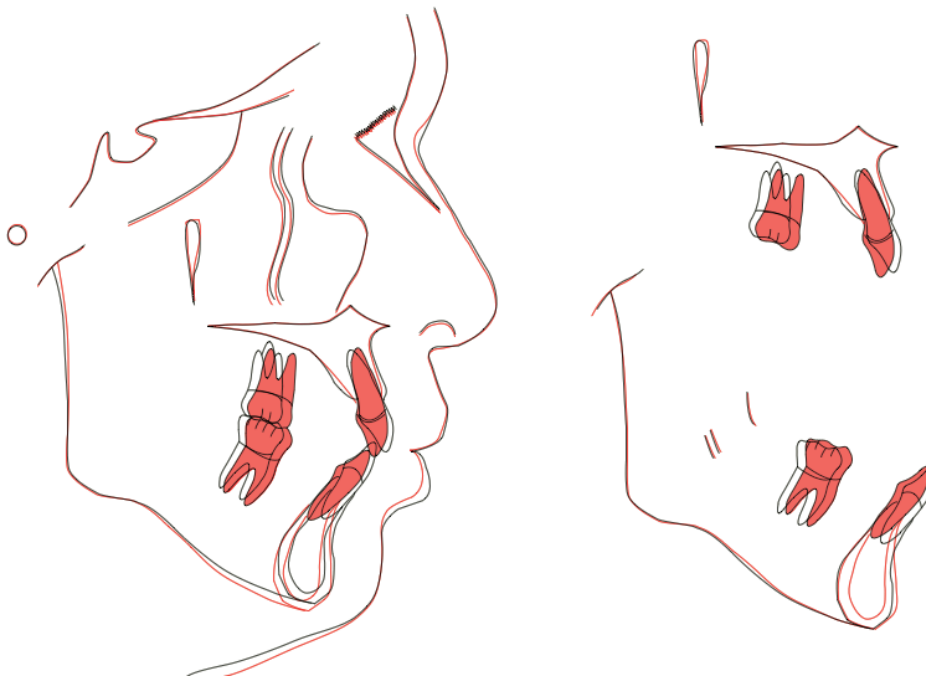
- A - P: Retraction of incisor
- Vertical: Maintain
- Inter-molar Width: Maintain



■ Fig. 7: Pretreatment pano. and ceph. radiographs



■ Fig. 8: Posttreatment pano. and ceph. radiographs



■ Fig. 9:

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



■ Fig. 10. The magnified view of the right maxillary canine-premolar transposition and general crowding before treatment.

#### Mandibular Dentition

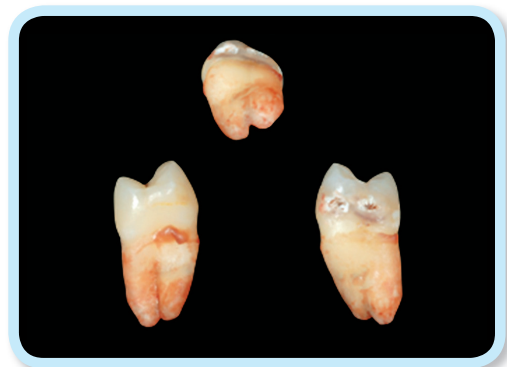
- A - P: mild retraction of incisors
- Vertical: Maintain
- Inter-molar / Inter-canine Width: Maintain

Facial Esthetics: Retraction of lower lip

#### Treatment Plan

The 1<sup>st</sup> premolars in all four quadrants were extracted to create space to correct crowding in both arches, as well as to align the transposed maxillary right canine. Examination of the extracted premolars (Fig. 11) demonstrates that the patient is caries susceptible. Bitewing radiographs are indicated to rule out other carious lesions. Posterior bite turbos were applied initially to facilitate bite opening and leveling. After the maxillary lateral incisor cross-bite was corrected, the posterior bite turbos were removed. The extraction space in the maxillary right quarter was used to correct the midline deviation.

In the later stage of the treatment, anterior bite turbos were used to assist in overbite and overjet correction. Following space closure, detailing bends were applied to produce the final occlusion. The



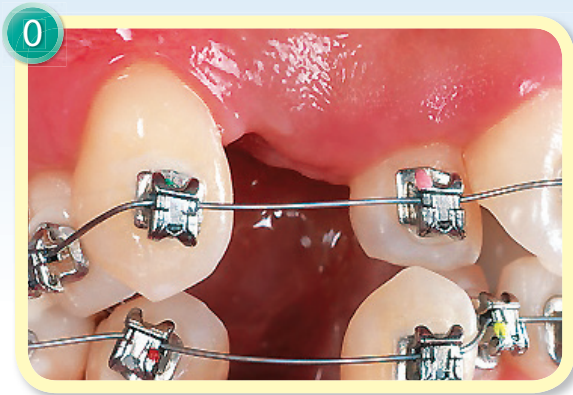
■ Fig. 11. extracted premolars with proximal caries.

fixed appliances were removed and the corrected dentition was retained with fixed anterior retainers (Mx 3-3, Md 5-5) in both arches.

#### Appliances and Treatment Progress

A .022" Damon D3MX bracket system (Ormco) was used. The maxillary arch was bonded with standard torque brackets on the anteriors, which led to problems as will be discussed later (Fig. 12) .

After six months of active treatment, the right maxillary canine and adjacent lateral incisor were aligned. Mandibular anterior teeth were aligned, as



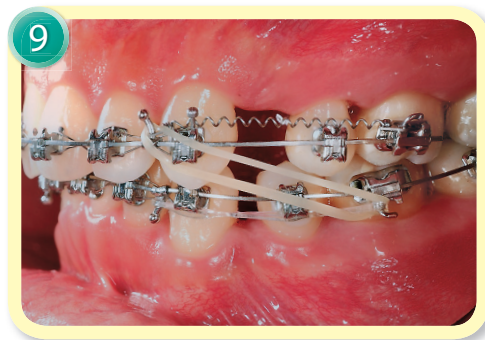
**Fig. 12:**  
faulty torque selection in right maxillary lateral incisor and canine.

the canines were retracted. The distal angulation of mandibular canines and increased Curve of Spee were noted at this stage (Fig. 13-14). The problem resulted from space closure with light archwires that failed to deliver adequate distal root torque in the mandibular anterior segment. After nine months of treatment, both arches were aligned to receive .019 x .025" SS arch-wires (Fig. 15) to correct the curve of Spee and provide additional distal root torque for space closure. The arch wire was cut distal to the left maxillary 1<sup>st</sup> molar. Anterior bite turbos and Class II elastics were utilized, from the left maxillary canine to the left mandibular first molar, to facilitate correction of the curve of Spee and retract the canines (Fig. 14). Following alignment, dark triangles developed between the central incisors, and the right central and lateral incisors (Fig. 15).

It took another eight months to close the left maxillary 1<sup>st</sup> premolar extraction space. The midline deviation was significantly improved but not fully corrected. In the 19<sup>th</sup> month of treatment, another panoramic film was taken, followed by re-bonding for detailing and correction of esthetic problems in the anterior region (Fig. 16). Triangle elastics were



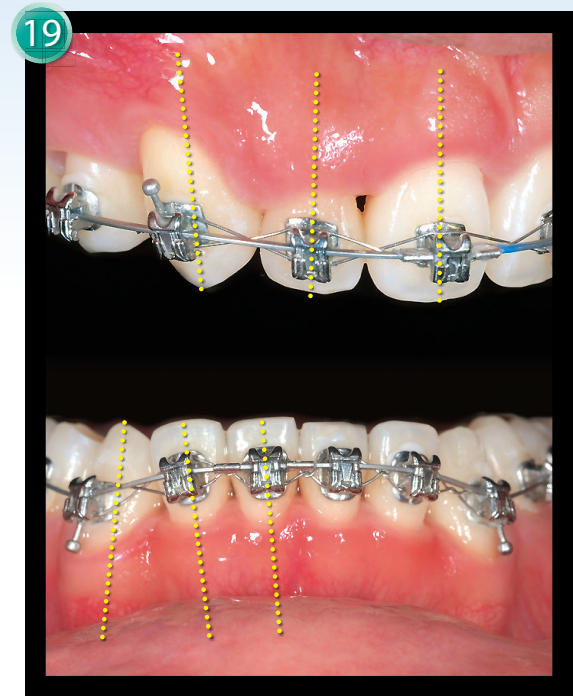
**Fig. 13:**  
6<sup>th</sup> month of treatment. Well aligned teeth in both arches and an increasing Curve of Spee in mandibular arch were noticed.



**Fig. 14:**  
Arch wire was cut end in the distal of left maxillary 1<sup>st</sup> molar with Class II elastic applied in major space closure.



■ Fig. 15:  
In the 9<sup>th</sup> month of treatment, a dark triangle was noted between the maxillary right central and lateral incisors.



■ Fig. 16:  
Mild angulation deviation causing the anesthetic result in both arches.

used bilaterally in the premolar region to settle the occlusion.

Archwire expansion was used to increase the mandibular inter-canine distance in the 23<sup>rd</sup> month of treatment. Following final detailing, all appliances were removed after 24 months. Upper clear overlay and fixed anterior (Mx 3-3, Md 5-5) retainers were delivered for both arches.

## Results Achieved

### Maxilla (all three planes):

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

### Mandible (all three planes):

- A - P: Maintained
- Vertical: clockwise rotation
- Transverse: Mild increase

### Maxillary Dentition

- A - P: Uprighting incisors 8 degrees
- Vertical: Molar extrusion
- Inter-molar / Inter-canine Width: Maintained

### Mandibular Dentition

- A - P: Maintained lower incisor angulation
- Vertical: Molar extrusion
- Inter-molar / Inter-canine Width: Maintained

Facial Esthetics: Moderate retraction of the lower lip

## Retention

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

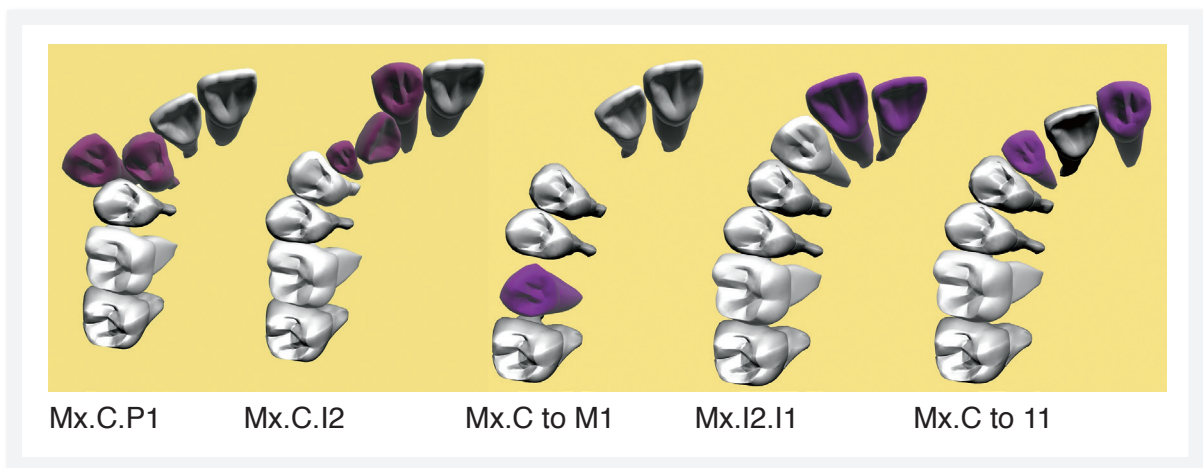
## Final Evaluation of Treatment

The ABO Cast-Radiograph Evaluation score was 26 points. The major discrepancies were in the right occlusal relationships, alignment/rotation, and marginal ridges. The upper dental midline discrepancy was decreased to 1.5 mm to the left of the facial midline. The transposed canine was well aligned, and the adjacent gingival texture was healthy (Fig. 20). However, the posttreatment panoramic radiograph shows an apparent, vertical osseous defect on the mesial of the right maxillary canine. Periodontal follow-up is indicated.

The use of Class II elastics was necessary to anteriorly reposition the mandibular dentition, because there was inadequate torque in the incisor brackets. Overall, this severe crowding case was treated to an acceptable facial and dental result, but the loss of alveolar bone height in the maxillary anterior region and possible vertical osseous defect must be carefully monitored (Fig. 8).

## Discussion

Tooth transposition is defined as the positional interchange of two adjacent teeth. This problem is more common in the maxillary arch. Although maxillary tooth transposition is an uncommon growth abnormality in the general population, the incident rate rises to approximately one in 300 orthodontic patients.<sup>1</sup> Peck et al. (Fig. 17) found that maxillary canine-first premolar transposition is the most frequent type. Typically, the transposed maxillary canine is found to be blocked-out facially between maxillary first and second premolar. The canine is usually rotated mesiofacially, and the first

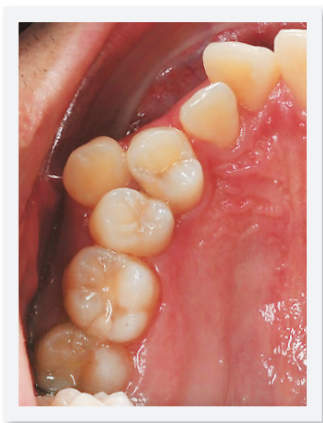


■ Fig. 17: Five types of maxillary tooth transposition introduced by Peck in 1995.<sup>1</sup>



premolar is distally tipped and rotated mesiopalatally (Fig. 18), with or without a primary canine in arch.<sup>2</sup> Genetics is the main etiologic factor for maxillary canine-first premolar transposition. After a thorough diagnosis, three treatment modalities are considered:

1. Non-extraction treatment and keep the transposed tooth order: Different root prominence and gingival margin discrepancy are expected to create a compromised result. Palatal cusp reduction of transposed maxillary first premolar is indicated in the latter stage of treatment, to achieve a better occlusion. With efficient mechanics, a acceptable esthetic and functional result can be achieved with a limited time in treatment.
2. Non-extraction treatment and correction of the transposed tooth order: Prolonged treatment time is expected with this treatment option. Furthermore, moderate root resorption of the canine and premolar is likely.<sup>3</sup> Increased



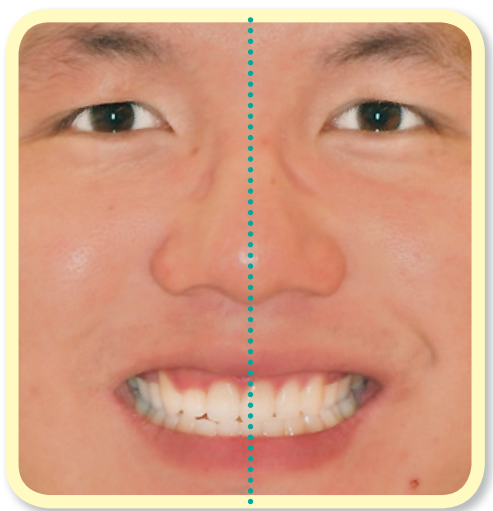
■ Fig. 18:  
Characteristics of typical maxillary canine-first premolar transposition was found in this case.

3. Extraction of transpositional first premolar: This is usually a relatively simple treatment option for crowded cases, with or without a convex profile. For the present case, generalized crowding and a mild lip protrusion indicated an extraction approach.

The third treatment plan was selected for the present case. Considering the advantage of low friction self-ligation bracket system (*Damon D3MX bracket system, Ormco*), an archwire was fully engaged in the first appointment for the distal tipped right maxillary canine.<sup>6</sup> The arch was aligned within six months, and no significant side effects were noted. One of the advantages of low friction self-ligating brackets is the shortened initial leveling

time in severe crowding cases, such as the present one.<sup>7</sup> However, the initial selection of standard torque for both the right maxillary lateral incisor and the canine compromised treatment progress (*Fig. 12*). Standard torque brackets failed to express adequate torque control during alignment and space closure. Other accessories are available for increased control of root torque, including anterior root torque spring (ART), which is compatible with the passive self-ligating system.<sup>8</sup> On the other hand, differential torque selection in the maxillary anterior region may have reduced treatment time and achieved a better root alignment result.<sup>9</sup>

In the 6<sup>th</sup> month of active treatment, initial leveling and alignment was complete, but more space closure (~8mm) was required on the left side of maxilla. Anchorage control in this case was crucial. The post-treatment midline was deviated 1.5 mm to the right of facial midline (*Fig. 19*). Midline correction would have been much more efficient if a miniscrew



■ *Fig. 19: Post treatment midline deviation.*

was placed in the infrazygomatic crest of left maxilla, to enhance anchorage during the space closure stage. Although Kokich<sup>10</sup> asserted that mild midline deviations can be disregarded, better anchorage control would have improved the result for this patient.

In cases of moderate to severe anterior crowding in adults, dark interproximal triangles are a common problem when the teeth are aligned.<sup>11</sup> Contributing factors include: 1. poor oral hygiene, 2. mal-alignment of the dentition, 3. undiagnosed insipient periodontitis, and 4. under-development of the gingival papillae (*Figs. 15 and 16*). Effective approaches for reducing black triangles are rebonding to correct axial inclinations of the teeth, interproximal enamel reduction, and closure of the residual space.

Anterior bite turbos with Class II elastics were effective for retracting the maxillary canines, as the lower the Curve of Spee was corrected. However, these mechanics resulted in molar extrusion and clockwise rotation of mandible (*Fig. 9*). Increasing lower facial height, as evidenced by the 3 degree increase in the SN-MP angle, was undesirable for a patient with a convex profile. This problem could have been prevented by the use of differential torque brackets in the anterior segments to prevent distal tipping and extrusion of the incisors as they were retracted.

Gingival margins of right maxillary lateral incisor and canine were not satisfactory. Obviously, the axial control of lateral incisor could have been improved.



■ Fig. 20: Post treatment frontal view

Gingivoplasty after debonding<sup>12</sup> might improve esthetics. Adding more palatal root torque in right maxillary canine is unlikely to improve the gingival height, and it would create an unesthetic overjet, that might compromise canine function. Given this patient's primary concerns, a functionally stable canine relation with moderate gingival recession was the best compromise.

The ABO CRE score was 26, with most of the points deducted in incisor and molar alignment errors. Rebonding brackets, or wire bending for detailing, could have improved the final result.<sup>13</sup>

## Conclusion

Treatment options for tooth transposition vary significantly. Correcting transposed teeth into anatomically normal positions may satisfying esthetic demands, but it complicates treatment. With careful diagnosis and adequate torque selection of brackets, acceptable results can be achieved nonextraction. As modern facial standards have evolved over the

past twenty years,<sup>14</sup> the common focus continues to be a full smile and reduced buccal corridors. In the presence of substantial crowding, extraction of the transposed premolar considerably simplified treatment. Despite an extraction or nonextraction approach, the use of inter-arch elastics, in patients with a convex profile, should be avoided, if at all possible.

Self-ligating brackets facilitate the efficient initial alignment to correct crowding. However, the importance of differential torque control for malaligned teeth is critical, as demonstrated in the present case. This moderately difficult malocclusion ( $DI = 15$ ) was treated to an acceptable result ( $CRE = 26$ ). The midline deviation could be improved by

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	75°	75°	0°
SNB°	74°	73°	0°
ANB°	1°	2°	1°
SN-MP°	35°	37°	2°
FMA°	28°	30°	2°
DENTAL ANALYSIS			
U1 TO NA mm	7 mm	6 mm	1 mm
U1 TO SN°	101°	93°	8°
L1 TO NB mm	5 mm	5 mm	0 mm
L1 TO MP°	98°	97°	1°
FACIAL ANALYSIS			
E-LINE UL	0 mm	-1 mm	-1 mm
E-LINE LL	2 mm	0 mm	-2 mm

■ Table. 1: Cephalometric summary

placing a miniscrew in the left posterior maxillary region.<sup>15</sup> The periodontal condition of the maxillary anterior region should be carefully evaluated. The posttreatment panoramic radiograph (Fig. 8) reveals decreased bone height in the maxillary anterior region, and there may be a vertical osseous defect on the mesial of the maxillary right canine.

## Acknowledgment

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## References

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# Discrepancy Index Worksheet

**TOTAL D.I. SCORE** = 15

**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 =

Total = 4

**OVERBITE**

- 0 – 3 mm. = 0 pts.
- 3.1 – 5 mm. = 2 pts.
- 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 = 7

**OCCCLUSION**

- 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 = 0

**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  $< -2^\circ$  \_\_\_\_\_ x 1 pt. = \_\_\_\_\_

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. = \_\_\_\_\_

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

Each degree  $> 99^\circ$  \_\_\_\_\_ 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 3<sup>rd</sup> molars) \_\_\_\_\_ x 2 pts. = \_\_\_\_\_

Midline discrepancy ( $\geq 3$ mm) @ 2 pts. = \_\_\_\_\_

Missing teeth (except 3<sup>rd</sup> molars) \_\_\_\_\_ x 1 pts. = \_\_\_\_\_

Missing teeth, congenital \_\_\_\_\_ x 2 pts. = \_\_\_\_\_

Spacing (4 or more, per arch) \_\_\_\_\_ x 2 pts. = \_\_\_\_\_

Spacing (Mx cent. diastema  $\geq 2$ mm) @ 2 pts. = \_\_\_\_\_

Tooth transposition \_\_\_\_\_ x 2 pts. = 2

Skeletal asymmetry (nonsurgical tx) @ 3 pts. = \_\_\_\_\_

Add. treatment complexities \_\_\_\_\_ x 2 pts. = \_\_\_\_\_

Identify:

Total = 2

**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) = \_\_\_\_\_

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

Bone level at adjacent teeth :  $\leq 5$  mm to contact point (0 pt), 5.5 to 6.5 mm to contact point (1 pt),  $\geq 7$  mm 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) = \_\_\_\_\_

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

Total = 0

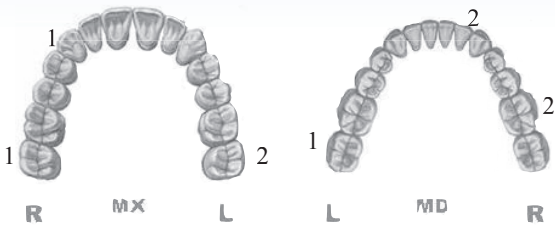
# Cast-Radiograph Evaluation

Case # 1 Patient

Total Score: **26**

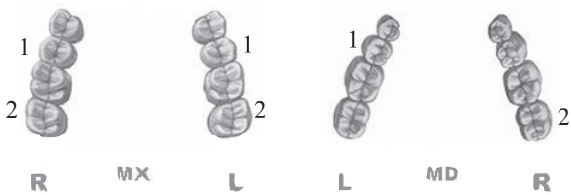
### Alignment/Rotations

9



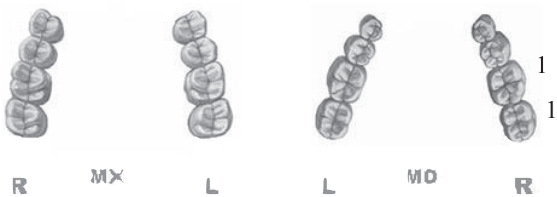
### Marginal Ridges

9



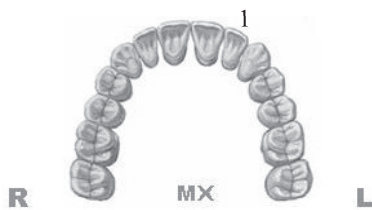
### Buccolingual Inclination

2



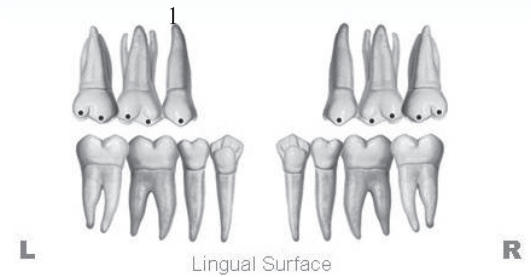
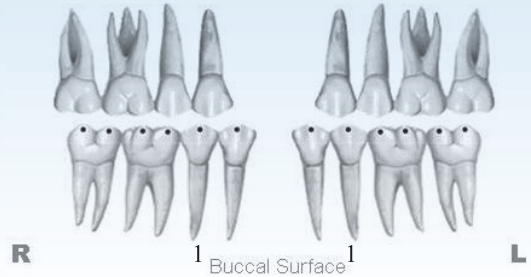
### Overjet

1



### Occlusal Contacts

3



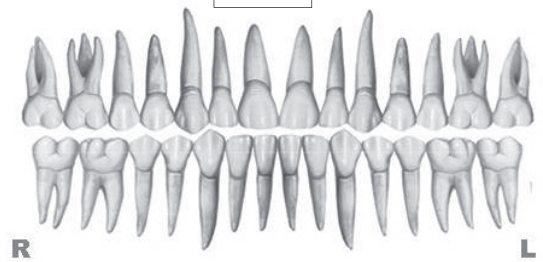
### Occlusal Relationships

0



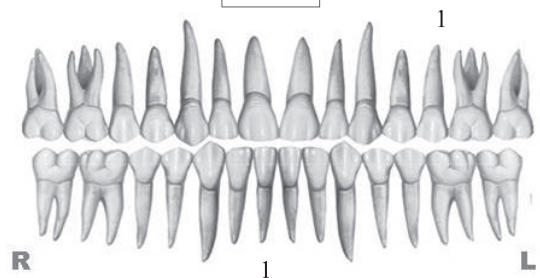
### Interproximal Contacts

0



### Root Angulation

2

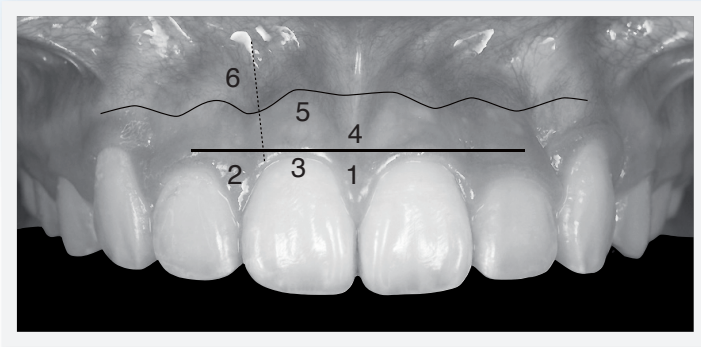


**INSTRUCTIONS:** Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

## IBOI Pink & White Esthetic Score

Total Score: = 5

### 1. Pink Esthetic Score

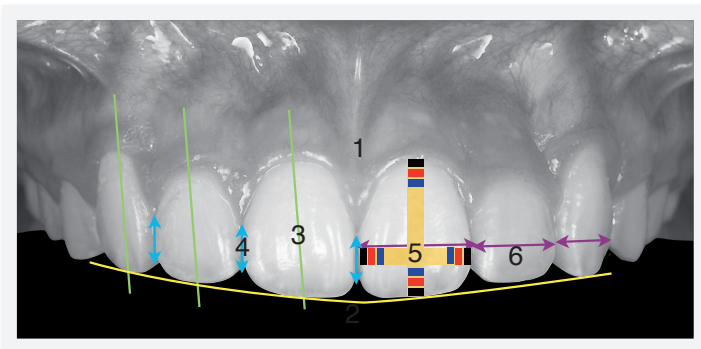


Total = 2

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 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

### 2. White Esthetic Score ( for Micro-esthetics )



Total = 3

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