

Insignia[®] System and IZC Bone Screws for Asymmetric Class II Malocclusion with Root Transposition of Maxillary Canine and Premolar

Abstract

An 18-year-old female sought consultation with a chief complaint: poor maxillary anterior esthetics.

Diagnosis & Etiology: Clinical examination revealed facial asymmetry: 1. nasal deviation to the right, 2. occlusal plane canted up on the left side, 3. maxillary midline 1mm left, and 4. mandibular midline 3mm left. Complex malocclusion had: 1. unilateral Class II malocclusion (subdivision left), 2. severe upper arch crowding, 3. blocked-out upper right canine (UR3), 4. mesial root transposition of the upper right first premolar (UR4), 5. lingual crossbite of the upper left lateral incisor (UL2), 6. buccal crossbite of the upper right 2nd molar (UR7), 7. retained upper right deciduous canine and 2nd molar, and 8. an impacted 2nd bicuspid (UR5). The etiology was deemed deviated path(s) of eruption, and habitual sleep posture on the right side of the face. The Discrepancy Index (DI) was 25.

Treatment Plan: 1. extract the retired deciduous teeth and instruct the patient to vary nocturnal sleep positions, 2. use the Insignia[®] system to produce a digital set-up of the final occlusion and reverse engineer a full fixed passive self-ligating (PSL) appliance to conform to the finishing archwires, 3. place posterior bite turbos on L6s to open the occlusion for correction the UL2 and UL7 crossbites, 4. use bilateral infrazygomatic crest (IZC) bone screws to differentially retract both arches to correct the unilateral Class II malocclusion with midline deviations, 5. move the UR3 mesially with a coil spring, 6. retract the UR4 with an elastomeric chain, and 7. finish with intermaxillary elastics.

Outcomes: This challenging malocclusion (DI 25) was treated in 20 months to a board quality result, as documented with a Cast-Radiograph Evaluation (CRE) of 24 and a Pink & White Esthetic Score of 2. The only significant deficiency was Class II buccal interdigitation on the right side. The patient was very satisfied with the outcome and was pleased with her “charming smile.”

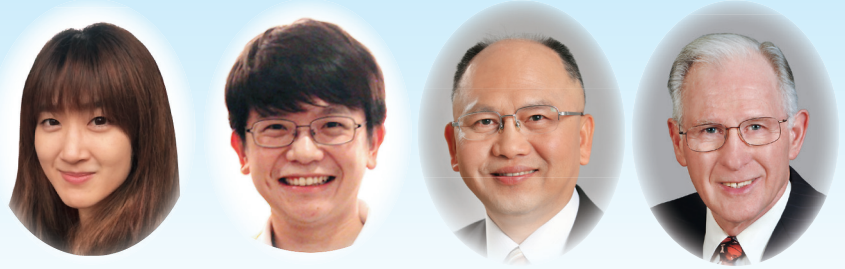
Conclusion: The Insignia[®] system is very precise and eliminates bracket positioning errors, so few detailing adjustments are required for alignment and finishing. This approach minimizes the repetitive PDL necrosis due to large number of active archwire segments, thereby resulting in a shorter treatment time. However, enamel stripping of the lower incisors and/or increased torque on the maxillary incisors was needed to completely correct the Class II buccal segment on the right side. (*J Digital Orthod* 2018;49:76-95)

Key words:

Insignia[®] system, passive self-ligating bracket, archwire sequence, custom bracket, canted occlusal plane, root transposition, IZC bone screws, miniscrew, Class II malocclusion, tooth size discrepancy, digital set-up.

Introduction

Insignia[®] (Ormco, Glendora, CA) was introduced by Dr. Craig Andreiko in 1987. It is a three dimensional (3D) reverse-engineered fixed appliance for the comprehensive treatment of all malocclusions.¹ Bracket placement is extremely accurate, so the initial digital set-up requires very careful attention; problems in the set-up are reflected in the finish. A precision fixed appliance produces a highly efficient, more continuous tooth movement process. Few if any detailing adjustments are required for aligning and finishing the final occlusion. Less repetitive periodontal ligament (PDL) necrosis occurs because fewer active archwires

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are engaged.^{1,2} The Insignia® system offers the potential for enhancing the rate of tooth movement and decreasing the incidence of root resorption.

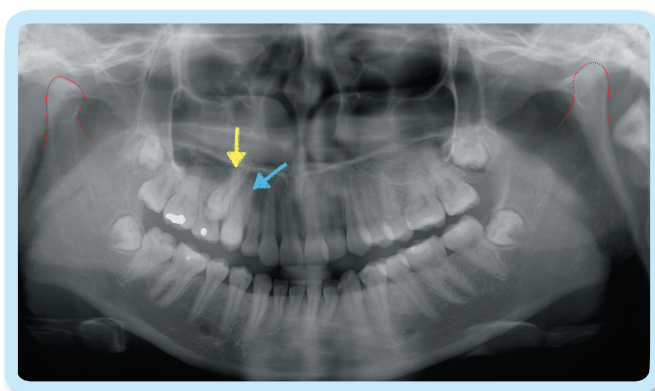
Transposition of teeth is a challenging problem for orthodontists. There can be a complete interchange or tipping of two adjacent teeth so that their crowns and/or roots are transposed. For this present patient (Figs. 1-2) the crown of an UR3 was immediately labial to the UR4, but the roots of the adjacent teeth are transposed (Fig. 3).



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



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



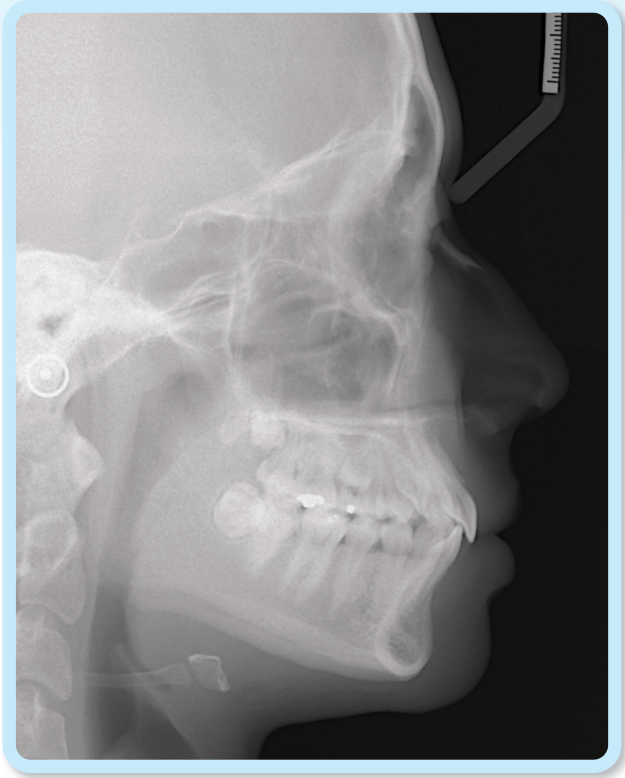
■ Fig. 3:
Pre-treatment panoramic radiograph. R and L condyles (red outline) are symmetrical. The upper right second premolar (UR5) is impacted (yellow arrow). The upper right canine (UR3) and the first premolar (UR4) had transposed roots (blue arrow).

Transposition is defined as a positional interchange of two teeth in the dental arch, and its prevalence is relatively rare (0.38%).³ The maxillary canine is the most prevalent transposed tooth. The problem is more commonly associated with the lateral incisor (1.64/1000) compared to the first premolar (0.91/1000).³ Dental transposition is primarily a genetic problem because it is more common in inbred groups.⁴ The treatment of dental transposition is controversial.

Factors such as gingival esthetics, canine eruption, caries risk, and duration of treatment are important considerations.⁵ The current case report presents the successful non-extraction treatment of dental root transposition, complicated by posterior buccal cross bite.⁶ Self-ligating brackets positioned with the Insignia® system^{1,2} are a good option for enhancing the efficiency of the mechanics.

Diagnosis and Etiology

An 18 year-old female sought consultation for an unattractive smile. There was no contributing medical history. Facial evaluation showed nasal deviation to the right, an occlusal plane that was canted superiorly on the left side, a convex profile (16°), and relatively retrusive upper lip (-3mm to the E-Line). The intraoral examination revealed a Class I molar relationship on the right and Class II on the left side. Overbite was 4mm, and overjet was 3mm. The left lateral incisor (UL2) was in lingual crossbite, and the UR7 was in buccal crossbite. Two retained deciduous teeth were noted in the upper left quadrant: canine and 2nd molar. There was a root transposition of the UR 3 and 4 (Figs. 1-3). The panoramic radiograph also revealed an impacted UR5. The etiology was probably a deviated path(s) of eruption. Mandibular condyles were relatively symmetric (Fig. 3). There were no signs or symptoms of temporomandibular joint dysfunction (TMD). Pre-treatment cephalometrics revealed bimaxillary protrusion (SNA 87.5°, SNB 83.5°, ANB 4°) with flared mandibular incisors (LI-MP 103.5°), while other values were within the normal limits (Fig. 4 and Table 1). The discrepancy index (DI) was 25 as shown in the subsequent worksheet.⁷



■ Fig. 4: Pre-treatment lateral cephalometric radiograph

Treatment Objectives

1. Correct the transposition and relieve the crowding
2. Correct the anterior and posterior crossbites
3. Class I canine and molar occlusion with coincident midlines
4. Correct occlusal cant, but maintain facial profile and lip position

Digital Set-Up

The occlusal views of the digital set-up are shown in Fig. 5, and the anterior perspective is documented in Fig. 6. Note that the maxillary midline is corrected 1mm to the right and the lower arch articulates

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	87.5°	87.5°	0°
SNB° (80°)	83.5°	83°	0.5°
ANB° (2°)	4°	4.5°	0.5°
SN-MP° (32°)	26.5°	27°	0.5°
FMA° (25°)	19.5°	20°	0.5°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	2 mm	0 mm	2 mm
U1 To SN° (104°)	107.5°	104.5°	3°
L1 To NB mm (4 mm)	5.5 mm	4 mm	1.5 mm
L1 To MP° (90°)	103.5°	99°	4.5°
FACIAL ANALYSIS			
E-LINE UL (2-3 mm)	-3 mm	-3 mm	0 mm
E-LINE LL (1-2 mm)	0 mm	0 mm	0 mm
%FH: Na-ANS-Gn (53%)	53.7%	53%	0.7%
Convexity: G-Sn-Pg' (13°)	16°	16.5°	0.5°

■ Table 1: Cephalometric summary

with the upper arch in a Class I relationship with coincident midlines. Details of the set-up are:

- Vertical movement:

Upper: Maintain upper incisors, extrude left buccal segment

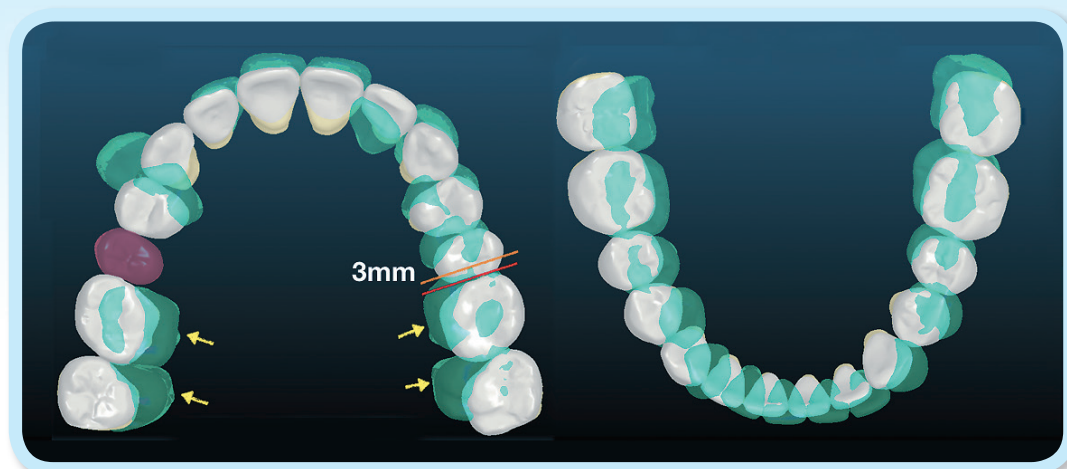
Lower: Intrude incisors 2mm

- Anterior overbite: 1.5mm

- Incisor axial inclinations:

Upper: Decrease torque 5 degrees

Lower: Decrease torque 5 degrees



■ Fig. 5:

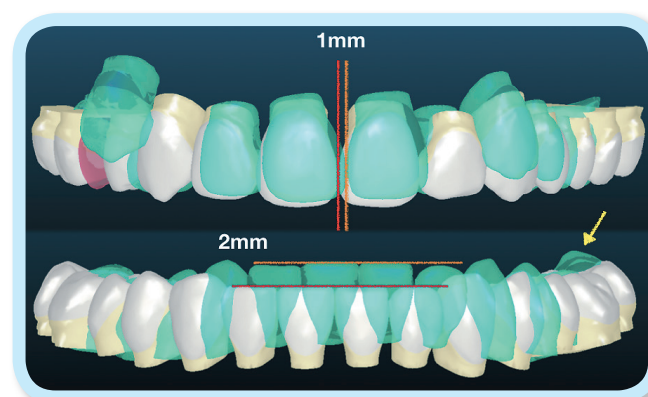
Occlusal views of the digital set-up show the post-treatment dentition (white) relative to the pretreatment morphology (green). Left: Orange line marks the mesial surfaces of the UL6 pre-treatment, and the red line is the mesial of the UL6 after 3mm of retraction. The purple tooth is the impacted UR5 moved into the arch. Yellow arrows show the directions of upper arch expansion. Right: The lower arch was expanded and rotated clockwise to coordinate with upper arch.

- Extraction of only the two retained deciduous teeth
- A/P movement (Fig. 5): Move UL6 distally 4mm
- Midline correction (Fig. 6): Upper midline 1mm right, lower midline 3mm right
- Archwire plane: Center of upper and lower central incisors
- Supplemental anchorage: Bilateral IZC miniscrews

overlays were fabricated. The patient was instructed to wear the overlays full time for the first 6 months, and nights only thereafter. Home care and retainer maintenance instructions were provided. After the

Treatment Progress

Before bonding the brackets, both retained upper right deciduous teeth were extracted. An Insignia® 0.022-in slot fixed appliance with passive self-ligating (PSL) brackets was bonded on all teeth in both arches except for the UR4 and UR5. The mechanics and wire sequence are documented in Table 2. Before the appliances were removed, at the end of active treatment, fixed lingual retainers were bonded on upper 2-2 and lower 3-3. Upper and lower clear



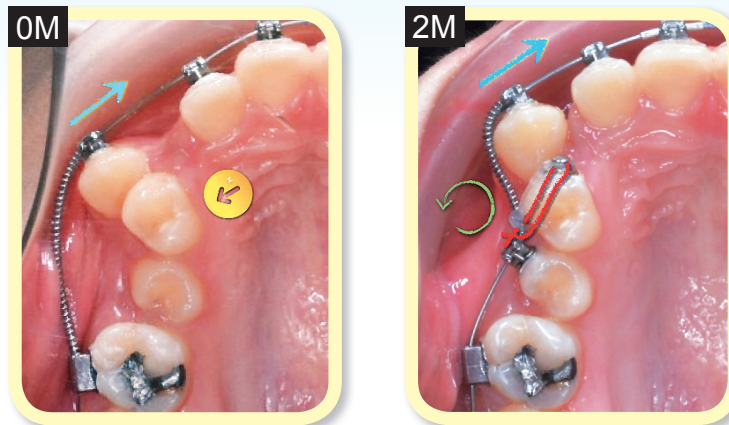
■ Fig. 6:

Frontal view of the digital set-up for the post-treatment dental alignment (white) is shown relative to the original occlusion (green).

Upper: Orange line marks pre-treatment midline and the red line shows its post-treatment position 1mm to patient's right.

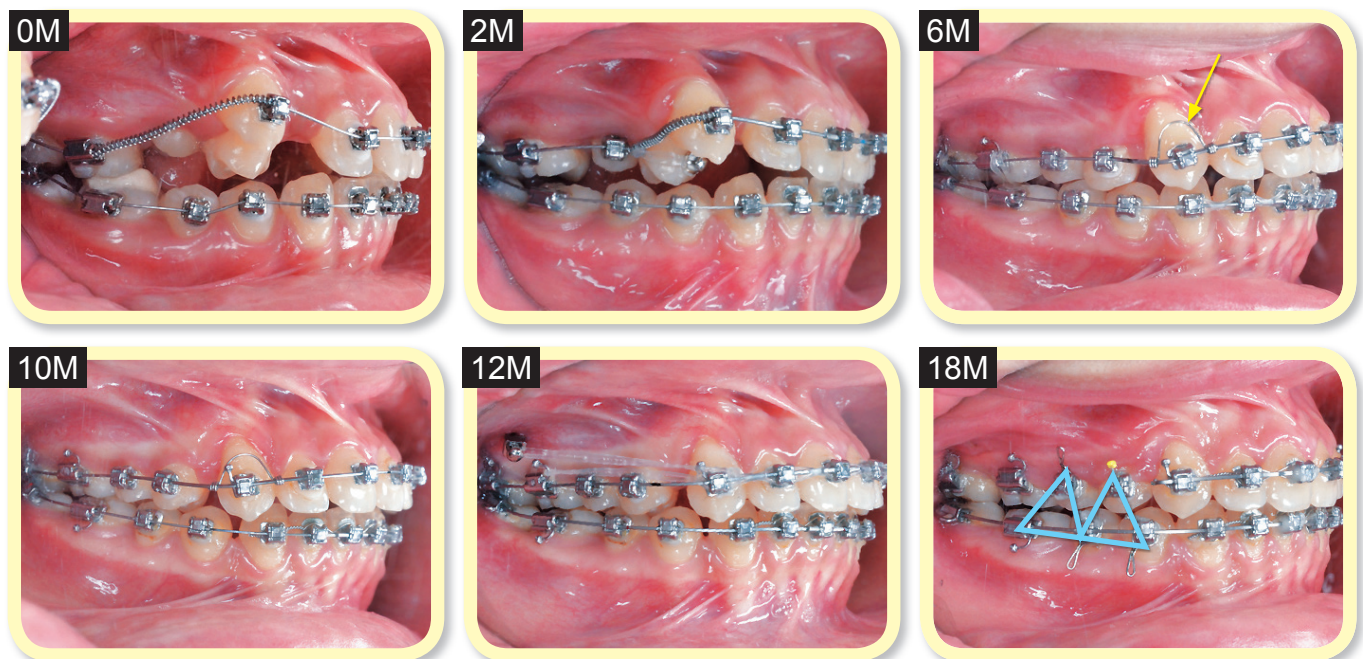
Lower: Orange line marks pre-treatment incisal edges, and the red line marks the 2mm of planned intrusion for the incisors. The yellow arrow points to intrusion of the LL molars to flatten the Curve of Spee.

orthodontic treatment was completed, a gingivectomy was performed with a diode laser to establish proper crown height and proportions. The total active treatment time was 20 months. Figs. 7-13 document the treatment progress as defined by the mechanics sequence outlined in Table 2.



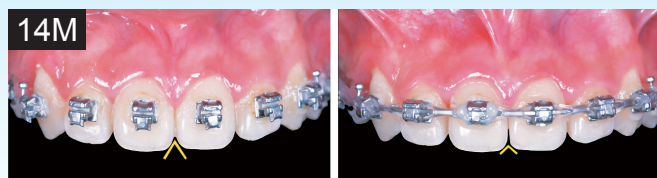
■ Fig. 7:

Left: At the start of treatment (0M), an open coil spring between the UR3 and UR6 was used to move the UR3 mesially (blue arrow). There is no bracket on the UR4, so it can move out of the way if contacted by the UR3 root (yellow circle with an arrow). Right: Two months into treatment (2M) the UR5 was bonded with a bracket, and a button was bonded on the labial surface of the UR4. A coil spring was activated to increase the space between the UR3 and UR5. An elastomeric ligature from the UR4 to the UR5 was used to rotate the UR4 mesial out (green curved arrow).



■ Fig. 8:

A series of right buccal photographs shows the progressive progress from the start of treatment (0M), during correction of the transposition at two months (2M), lingual root torquing spring (yellow arrow) on the UR3 at six months (6M), alignment prior to space closure at ten months (10M), upper arch space closure at twelve months (12M), and settling of the posterior occlusion with triangular elastics (blue). See text for details.

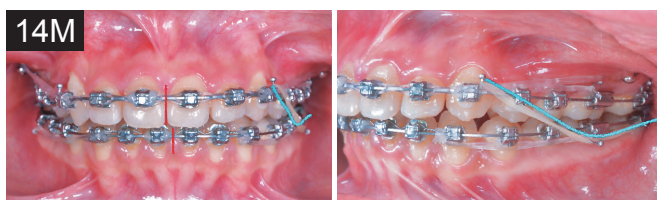


■ Fig. 9:

Enamel interproximal reduction (IPR) was performed on the mesial surfaces of the maxillary central incisors to reduce the occlusal embrasure (yellow inverted V). Note that this procedure contributed to failure to correct the Class II buccal segment on the left side. See text for details.

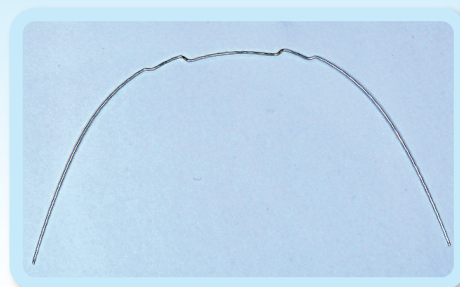
Left: Pre-treatment

Right: Post-treatment



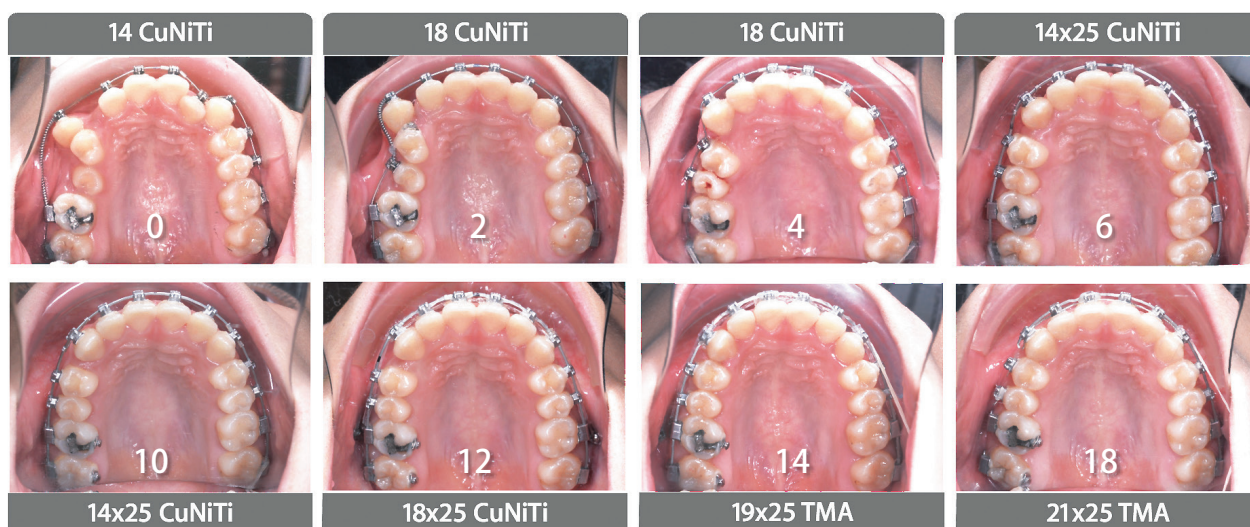
■ Fig. 10:

A unilateral left L-type Class II elastic (Fox ¼-in, 3.5-oz) (blue lines) was utilized from UL3 via the LL6 to the LL7 to achieve midline correction by asymmetrically advancing the LL buccal segment. Elastomeric chains anchored by the IZC bone screws were attached to the U3s to retract the entire upper arch. See text for details.



■ Fig. 11:

Prior to debonding, a 0.018-in stainless steel wire was adjusted to rotate the upper lateral incisors mesial out (upper image). The maxillary incisors were ideally positioned prior to bonding a fixed lingual retainer (center image). Because of occlusal interference on closing, the fixed retainer was repositioned more gingivally prior to removing the brackets (lower image). See text for details.

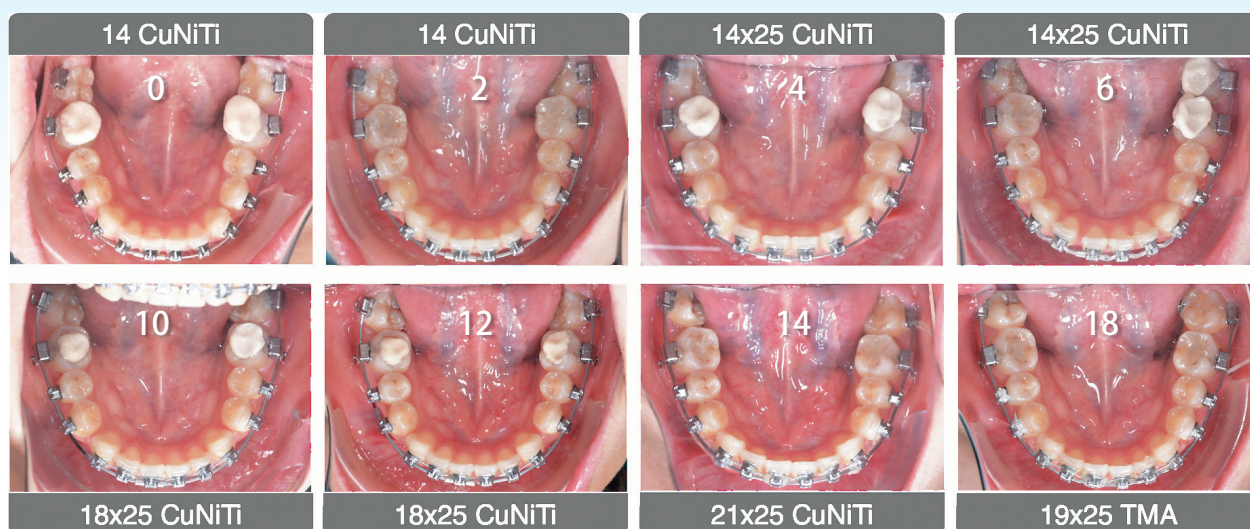


■ Fig. 12:

A progressive series of upper occlusal photographs shows the archwire inserted at given intervals in months as shown in the posterior palate. Eight treatment intervals are illustrated: 0, 2, 4, 6, 10, 12, 14 and 18 months.

Appointment	Archwire	Notes
1 (0 months)	U/L: 0.014-in Damon CuNiTi	An open coil spring between UR3 to UR6. No brackets were bonded on UR4 to allow it the freedom to move out of the path of tooth movement (Fig. 7). Bite turbos were constructed with Fuji II type II glass ionomer cement (GC America, Alsip IL) on the occlusal surfaces of the mandibular first molars in order to facilitate correction of UL2 and LL7 crossbites in addition to LR7 uprighting.
2 (1 month)	L: 0.014x0.025-in Insignia CuNiTi	
3 (2 months)	U: 0.018-in Damon CuNiTi	The UR5 had adequate crown exposure to bond the bracket. A button was bonded on the mesio-labial surface of the UR4 to receive an elastomeric chain with elastomeric ligature from UR4-UR5 to rotate the UR4 mesial out. The bite turbos were removed after the UL2 crossbite was corrected.
4 (4 months)		Bite turbos were replaced on the L6s to open the occlusion so that cross elastics (Chipmunk 1/8-in, 3.5-oz), from the buccal hooks on the U7s to the lingual buttons of the lower 7s to upright the L7s.
5 (6 months)	U: 0.014x0.025-in Insignia CuNiTi	After preliminary alignment was achieved, torque control began with the rectangular archwire and a torquing spring to move the root lingually was applied on the UR3 (Fig. 8).
6 (8 months)	L: 0.018x0.025-in Insignia CuNiTi	With torque control established in the lower arch, bilateral Class II elastics (Parrot 5/16-in, 2-oz) were worn from the upper canines to the lower first molars were used to reduce overjet.
7 (12 months)	U: 0.018x0.025-in Insignia CuNiTi	Two OrthoBoneScrews® (Newton's A Ltd, Hsinchu, Taiwan) were inserted bilaterally into the IZC area as anchorage to correct the maxillary dentition. The torquing spring on UR3 was removed.
8 (13 months)	U/L: 0.019x0.025-in Insignia TMA	Upper archwire expansion.
9 (14 months)		UR3 bracket was repositioned. IPR was performed on the upper dental incisors to reduce the mesial incisal embrasures (Fig. 9). The upper archwire was expanded to correct posterior overjet. A unilateral L-type Class II elastic (Fox 1/4-in, 3.5-oz) was utilized from UL3 via LL6 to LL7 for midline correction (Fig. 10). A cross-elastic (Kangaroo 3/16-in, 4.5-oz) from the UR bone screw to the LR7 lingual button uprighted the LR7.
10 (15 months)	L: 0.021x0.025-in Insignia TMA	Upper archwire expansion.
11 (17 months)	U: 0.021x0.025-in Insignia TMA L: 0.019x0.025-in Insignia TMA	First order bends were applied for mesial-out rotation of the U2s.
12 (18 months)		The IZC bone screws were removed. To detail the occlusion, the upper archwire was cut distally to UR3, and triangle elastics (Kangaroo 3/16-in, 4.5-oz) were attached to seat the maxillary teeth on the mandibular dentition, which was stabilized with an archwire (Fig. 8). ⁶ A first order bend was applied for LL6 mesial-out rotation.
13 (19 months)	U: 0.018-in SS	Canine off-set bends were placed in the upper archwire.
14 (20 months)		Detailed finishing of upper incisors prior to placing upper and lower fixed lingual retainers (Fig. 11). All fixed appliances were removed.

■ Table 2: Treatment Sequence.



■ **Fig. 13:** A corresponding series of lower occlusal views shows the same treatment progression as Fig. 12.

Treatment Results

Facial esthetics were maintained. Good dental alignment and intermaxillary occlusion was achieved (Figs. 14 and 15). No periodontal problems were noted. The post-treatment panoramic radiograph documented acceptable root parallelism, except for the UL4 and LR7 (Fig. 16). The facial profile and vertical dimension of occlusion were maintained (Figs. 17 and 18). Superimposed cephalometric tracings showed the maxillary arch was retracted about 2mm with IZC bone screw anchorage, and torque control of the upper incisor was moderately decreased 3° ($U1-SN$ 104.5°). The increased axial inclination of the lower incisors was improved 4.5° ($L1-MP$ 99°). Correction of the posterior crossbite increased the mandibular plane angle 0.5° ($SN-MP$ 27°). The patient was well satisfied with the result. Intraoral photos at one and four months follow-up demonstrate a stable occlusion and healthy periodontium (Figs. 19 & 20). The ABO CRE score was 24 points, as shown in the supplementary CRE

chart.⁸ The principal deficit in the final alignment was a Class II left buccal interdigitation. The Pink and White dental esthetic score was 2 points.⁹

Discussion

Insignia®: a Custom Bracket System

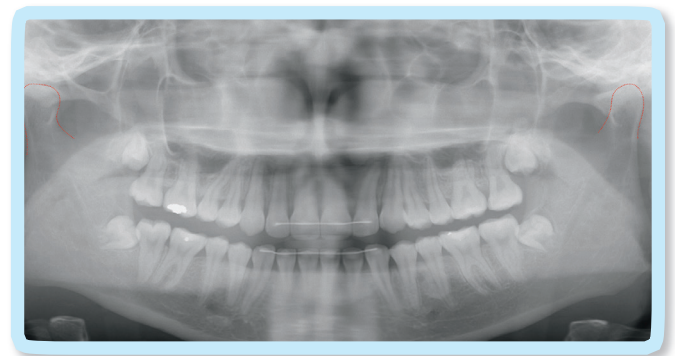
Insignia® is a 3D reverse-engineered fixed appliance for the comprehensive treatment of all malocclusions. It is extremely accurate and efficient, but requires very careful detail to the digital set-up, from which the appliance is constructed.^{1,2} For the present patient, crowding and transposition correction was accomplished in only 6 months (Fig. 12) with no detailing bends or bracket repositioning. These mechanics control PDL stress to enhance the rate of tooth movement and minimize the risk of root resorption.^{1,2} The recommended archwire sequence is summarized in Table 3.



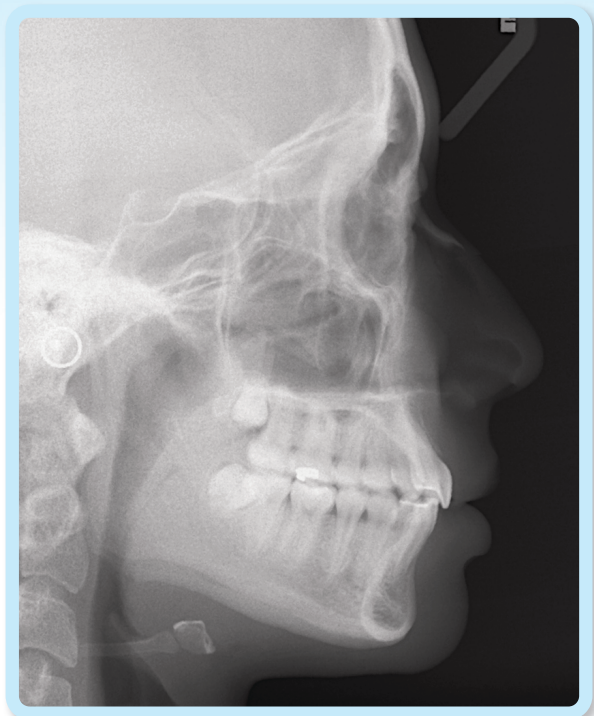
■ Fig. 14: Post-treatment facial and intraoral photographs



■ Fig. 15: Post-treatment dental models (casts)



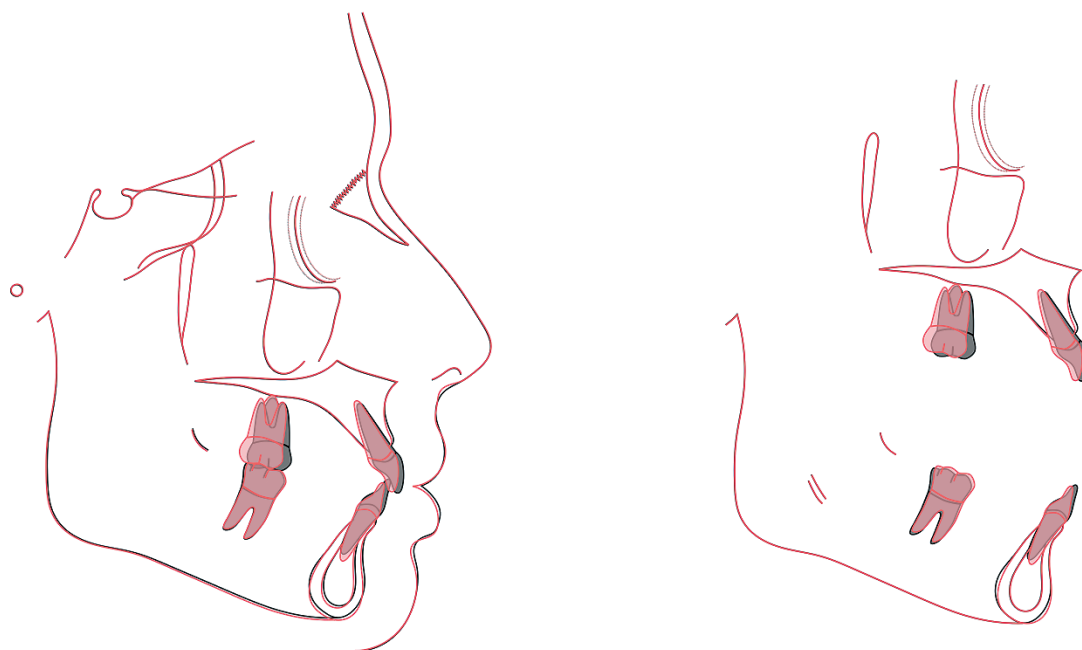
■ Fig. 16: Post-treatment panoramic radiograph



■ Fig. 17: Post-treatment lateral cephalometric radiograph

Phase I: Stock light round wires

As detailed in Table 3, the initial treatment objectives were: (1) place bilateral bite turbos on the occlusal surfaces of the lower first molars to open the articulation for crossbite correction, (2) level and align, (3) initiate arch development as needed, and (4) resolve 90% of the rotations. The management of the root transposition of the UR4 began with space opening, bonding a bracket on the erupting UR5, and continuing space opening between the UR5 and UR3 (Fig. 7) while the UR4 was rotated distal in. The flexibility of the initial round archwire (0.014-in CuNiTi) minimized friction and binding, so the initial alignment of the UR buccal segment was accomplished in <6 months (Fig. 8).



■ Fig. 18:

Tracings of the pre-treatment (black) and post-treatment (red) cephalometric radiographs are superimposed on the anterior cranial base (left), maxilla (upper right) and mandible (lower right). See text for interpretation.

Phase II: Insignia® rectangular CuNiTi wires

The objectives of the second phase were to: (1) begin resolving torque and root angulation problems, (2) complete leveling and alignment, (3) finish rotation corrections, and (4) continue arch form development, as needed. In this stage, the UR3 received a torque spring to increase its axial inclination. Early control of the axial inclination of the UR3 contributed to good torque expression in the middle of treatment (Fig. 8).¹⁰

Phase III: Major mechanics

The objectives of the third phase (12-18 months) were to close spaces and correct intermaxillary relationships. IZC bone screws were inserted bilaterally to retract the entire maxillary dentition for Class II correction.¹¹ Interdental spaces were closed with elastomeric chains (Fig. 8). At 14 months, interproximal enamel reduction (IPR) was performed

to correct the wide embrasure between the maxillary central incisors (Fig. 9). At the same appointment, a L-type Class II elastic was applied on the left side to align the mandibular midline (Fig. 10).

Phase IV: Finishing

The objectives for the final phase of treatment were to complete torque expression and arch coordination to achieve ideal intra-arch and intermaxillary alignment. Midline elastics were applied and maxillary arch expansion was completed. The lingually-inclined LR7 was uprighted by engaging full-sized wires and applying cross elastics anchored by the UR IZC bone screw. The posterior occlusion was settled with two triangle elastics bilaterally (Fig. 8). At the conclusion of active treatment, first order (*in-and-out*) bends were applied for final detailing and finishing at the same debonding visit (Fig. 11). Occlusal views of progress related to the archwire sequence are shown for the

Insignia Archwire Sequencing

I	Stock light round wires	0.014 0.016 / 0.018 (alternative)	Stock Damon CuNiTi
II	Insignia edgewise CuNiTi wires	0.014 x 0.025 0.018 x 0.025 0.021 x 0.025	Insignia CuNiTi
III	Major mechanics	0.019 x 0.025	Stock SS
IV	Finishing	0.021 x 0.025 0.021 x 0.025 0.019 x 0.025 (backup)	Insignia CuNiTi Insignia TMA Insignia TMA

■ Table 3: The recommended archwire sequence is summarized for progressive archwire therapy utilizing the Insignia bracket system.

maxillary (Fig. 12) and mandibular (Fig. 13) arches. The finished occlusion is documented at 20 months, after the brackets were removed and fixed retainers were placed (Figs. 14-18), and after 1-5 months of follow-up (Figs. 19 and 20) when restorative care was completed.

Extra-Alveolar Bone Screw Anchorage

Extra-alveolar (E-A) skeletal anchorage is well suited for asymmetric sagittal discrepancies because the bone screws are buccal to the molars rather than between the roots. For the present patient, the Class II



■ Fig. 19:

The upper three images show the treatment outcome at twenty months (20M). The corresponding lower three views document the stable and healthy result at one-month follow up (1m-F/u).



■ Fig. 20:

Right buccal views compare the immediate post-treatment result at twenty months (20M) (left) to one month follow-up (1m-F/u) (center), and five month follow-up (5m-F/u). See text for details.

malocclusion on the left side was partially corrected by retracting the buccal segment with an elastic chain anchored by an IZC bone screw. The Class II relationship on the left side was not completely corrected because of inadequate overjet to retract the left maxillary quadrant to Class I. The lack of overjet was due to: 1. lingually tipped upper incisors, 2. labially tipped lower incisors, 3. tooth size discrepancy between the upper and lower incisors, and 4. the enamel stripping performed on the medial surface of the maxillary central incisors to correct the embrasure (Fig. 9). Near the end of treatment this problem was still correctable by adjusting incisor torque or IPR and retraction of the lower incisors. However, maintaining the midline correction (Fig. 21) required limiting the enamel stripping to the LL quadrant (*teeth LL1-4*).



■ Fig. 21:

Left: Compared to the facial midline (black line), the pre-treatment maxillary midline is deviated to the patient's left 1mm, and the lower midline is 3mm to the left.

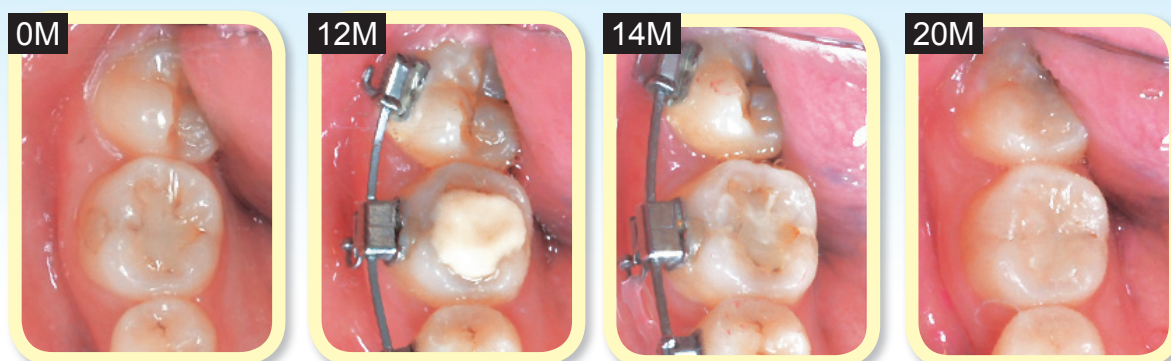
Right: Post-treatment, the upper and lower midlines are coincident with the facial midline (black line). See text for details.

Class II malocclusions with moderate crowding treated non-extraction with passive self-ligating brackets can be well aligned, but the outcome is often accompanied with incisal flaring and lip protrusion.¹¹ E-A IZC miniscrews provide osseous anchorage to easily prevent those problems. Furthermore, the right IZC bone screws are effective anchorage for uprighting lingually-tilted lower second molars with cross-elastics (Fig. 22). Low profile tubes are particularly effective for buccal crossbite correction because they are less likely to interfere with occlusion, which often results in bond failures (Fig. 23).

CBCT images reveal that the IZC bone screw on the left side penetrated the maxillary sinus (Fig. 24), but there were no negative consequences for the patient.¹² Both IZC bone screws were stable throughout the treatment and there were no problems with soft tissue irritation.

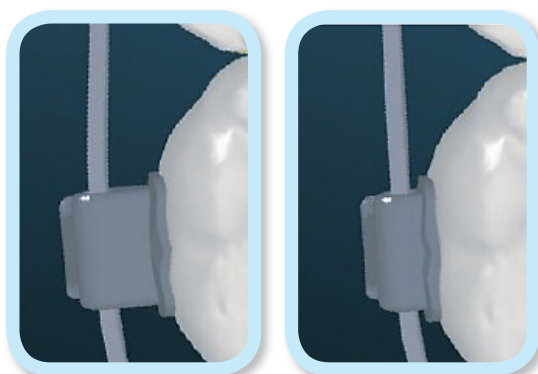
Transposition

Transposition is a rare anomaly defined as two teeth exchanging positions.^{13,14} Etiology is predominately genetic,¹⁵⁻¹⁷ and the problem may occur bilaterally. Maxillary canines (*U3s*) are the common transposed teeth, probably because they are the last succedaneous teeth to emerge in the mouth. The most common transposition locations are distal to the *U4* and mesial to the *U2*. Both variations may be affected by crowding, crossbite or a deviated path of eruption. If transposed with the adjacent *U4*, the canine is usually rotated mesial out, while the first premolar is tipped distally, and rotated



■ **Fig. 22:**

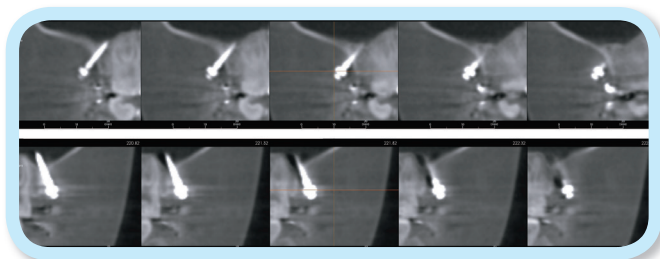
The LR7 is tipped lingually prior to treatment (0M). Twelve months (12M) into treatment the LR7 has failed to upright with a rectangular archwire and bite turbo on the LR6. At fourteen months (14M) a cross elastic was applied from a lingual button on the LR7 to the IZC bone screw. The LR7 was well corrected by the end of treatment at 20 months (20M). See text for details.



■ **Fig. 23:**

Left: Original version of the TIB tube has a prominent buccal profile that is susceptible to occlusal interference and debonding.

Right: New low profile TIB tube has an improved design to resist debonding due to occlusal interference.



■ **Fig. 24:**

A strip of CBCT coronal views shows the left bone screw was within bone (upper). However, the bone screw installed on the right side penetrated the maxillary sinus, but there were no adverse signs or symptoms. See text for details

mesial in. The maxillary deciduous canine may be retained creating a transient arch space deficiency.¹⁸ Transposition may be complete or incomplete. In a complete transposition, both the crown and the entire root are in their transposed position. In an incomplete transposition, the crowns may be transposed, but the root apices still remain in their normal positions.¹⁹ Alternately the roots but not the crowns of the teeth may be transposed (Figs. 2 and 3). The treatment of dental transposition is controversial and depends on the severity of the problem. Treatment alternatives include alignment in the normal or transposed position, or extraction of one of the transposed teeth, followed by space closure.²⁰ Common treatment options are:

1. Non-extraction Treatment: Maintaining the transposed tooth order. When transposed teeth are fully erupted and well aligned in the transposed position, maintaining the transposition order is a viable option.²¹⁻²² However, esthetic and functional problems are common, such as atypical root prominence and gingival margin contours can be expected.

If the palatal cusp of a transposed premolar produces occlusal problems, such as a balancing interference, occlusal adjustment is indicated to control the risk of pulpitis or TMD. Furthermore, the buccal cusp of the first premolar is smaller than the canine and the gingival margin is more occlusal, so a restorative build-up procedure may be needed. For more ideal esthetics, a transposed upper premolar can be intruded to simulate the gingival contour of a canine, and then restored with a full coverage restoration.

2. Non-extraction Treatment: Correcting the transposed tooth order. The drawbacks for orthodontic correction are complex mechanics, long treatment time, root resorption, and periodontal clefting or dehiscence.¹⁸
3. Extraction of the Transposed First Premolar: This is usually the best option for crowded cases that require extraction,¹⁹ but it may still be the treatment of choice if the buccal segment(s) can be moved mesially to close the space. Mesial space closure in the upper arch is readily accomplished if there is a relatively deep overbite.²³ Otherwise, E-A bone screws may be needed for osseous anchorage.

For the present patient, the second treatment option was deemed appropriate because the UR3 and UR4 transposition was incomplete, she was young (18y/o), and the facial profile was acceptable. The risk of root damage as the transposed roots are moved past each other is minimized by only bonding a bracket on the tooth that is directly exposed to mechanics (UR3). For instance, no bracket was attached to

the adjacent UR4, so the latter could act as a free body, and physiologically move out of the path of tooth movement if its root is engaged by the root of the UR3. With the aid of the Insignia® system, the transposed teeth were corrected in only 4 months, and the entire comprehensive treatment only required 20 months.

Conclusions

1. Dental transposition is a complex functional and esthetic problem that is a treatment challenge because correcting the natural tooth order is time consuming, and risks both hard and soft tissue damage.
2. Maintaining the transposed tooth order and restoring esthetics and function may be a viable option. Preprosthetic orthodontics to align gingival margins can greatly enhance the final result.
3. Insignia® is a powerful weapon for managing complex orthodontic problems. Optimal bracket positions that require few if any detailing adjustments are particularly important for complex, time consuming treatment plans.
4. IZC bone screws are E-A osseous anchorage that are particularly effective for non-extraction treatment of asymmetric malocclusions, such as unilateral transpositions.

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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 = **1**

Total = **1**

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**

OCCLUSION

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

Total = **4**

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = **0**

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = **2**

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. =

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

Each degree $> 99^\circ$ **5** x 1 pt. = **5**

Total = **5**

OTHER (See Instructions)

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

Identify:

Total = **4**

Cast-Radiograph Evaluation

Case #

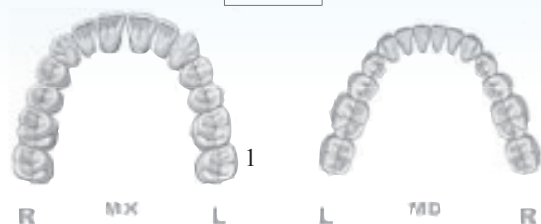
Patient

Total Score:

24

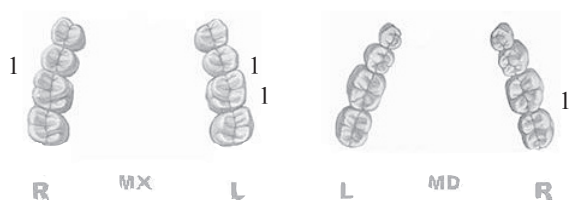
Alignment/Rotations

1



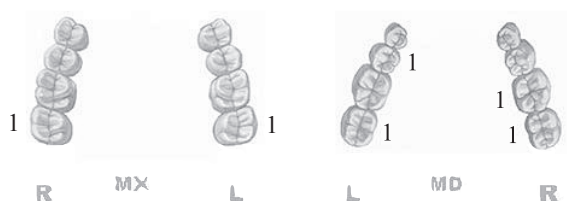
Marginal Ridges

4



Buccolingual Inclination

6



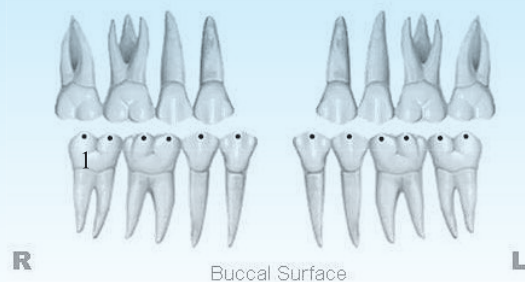
Overjet

0

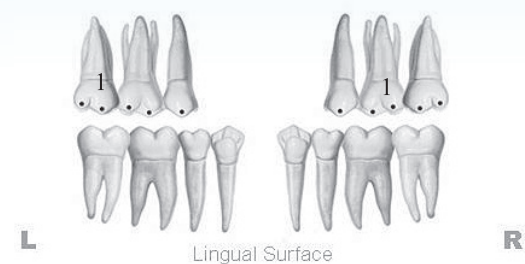


Occlusal Contacts

3



Buccal Surface



Lingual Surface

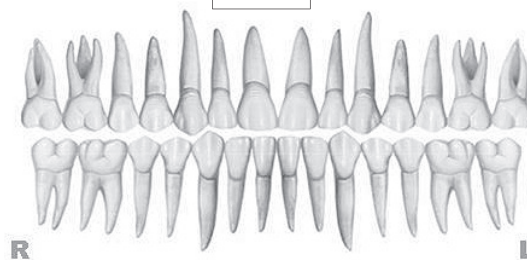
Occlusal Relationships

8



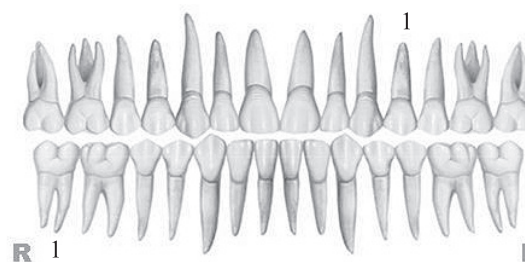
Interproximal Contacts

0

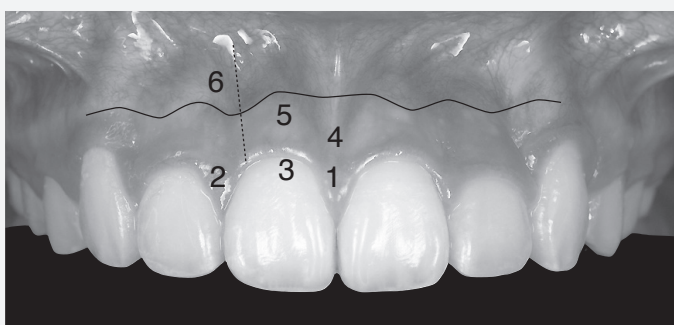


Root Angulation

2

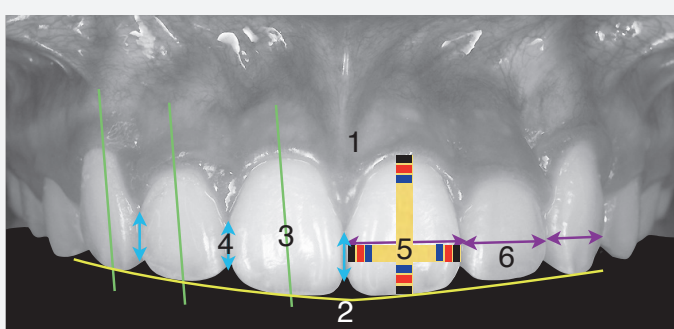


INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score (Before Surgical Crown Lengthening)Total Score: = **2****1. Pink Esthetic Score**

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

Total = **0****2. White Esthetic Score (for Micro-esthetics)**

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

Total = **2**