Probable Airway Etiology for Skeletal Class III Openbite Malocclusion with Posterior Crossbite: Camouflage Treatment with Extractions

Abstract

History: *A 27-year-old male presented for orthodontic consultation with a chief complaint (CC): front teeth do not contact. Upper right canine (UR3*) was previously extracted to alleviate maxillary crowding. Previous doctors suggested orthognathic surgery, but the patient was concerned about the cost and morbidity. Beethoven Orthodontic Clinic was consulted because of the reputation for managing skeletal openbite malocclusion conservatively.*

Etiology: *A childhood airway problem, probably related to enlarged pharyngeal lymphoid tissue, resulted in anterior posturing of the mandible and low tongue posture to open the airway. The patient is now able to breath through the nose with the mouth closed. Orthodontic correction of the malocclusion is expected to spontaneously resolve the low tongue posture which is the proximal cause of the anterior openbite and posterior crossbite.*

Diagnosis: *Skeletal (SNA 83˚, SNB 86˚, ANB -3˚) Class III malocclusion (10mm bilaterally) was combined with 6mm anterior openbite and bilateral posterior crossbite. The UR3 was missing and the maxillary midline was deviated 3mm to the right. The patient could breathe normally through the nose with the lips closed. The Discrepancy Index (DI) for this severe skeletal malocclusion was 103.*

Treatment: *Instruction and reinforcement of normal tongue posture is emphasized throughout treatment. Correct crowding and establish symmetry for the missing UR3 by extracting UL4, UR4, and LL4. Resolve the posterior crossbite with rapid palatal expansion of the maxillary arch, followed by cross elastics. Install a full fixed appliance with passive self-ligating brackets. Utilize standard torque for upper anteriors and super-high torque for lower anteriors. Supplement the torque correction in the lower anterior segment with an archwire sequence of 0.016x0.025-in 34mm with 20˚ Pre-Torque CuNiTi, and 0.016x0.025-in stainless steel with 3rd order bends. Follow-up with torquing auxiliary springs as needed.*

Results: *After 33 months of active treatment, this severe skeletal malocclusion was conservatively corrected to a near ideal Class I occlusion without orthognathic surgery or temporary anchorage devices (TADs). The Cast Radiograph Evaluation (CRE) was 22 points, and Pink & White dental esthetics score was 0.*

Conclusion: *Severe Class III openbite malocclusion may result from airway-related anterior positioning of the mandible and low tongue posture during childhood. Conservative correction with extractions and differential space closure is indicated, if the patient is able to breathe normally through the nose with the mouth closed. Spontaneous correction of the aberrant postural habits is probable when the malocclusion is corrected. Otherwise, specific habit correction therapy is indicated. (J Digital Orthod 2019;54:54-76)*

Key words:
Class III malocclusion, anterior crossbite, anterior open-bite, posterior cross-bite, etiology, childhood airway insufficiency, pharyngeal lymphoid tissue, torque selection

** International dental nomenclature is a modified Palmer notation relative to the midline for: 1. quadrants which are upper (U) and lower (L) on the right (R) and left (L) sides, 2. deciduous teeth are a-e, and 3. permanent teeth are 1-8.*

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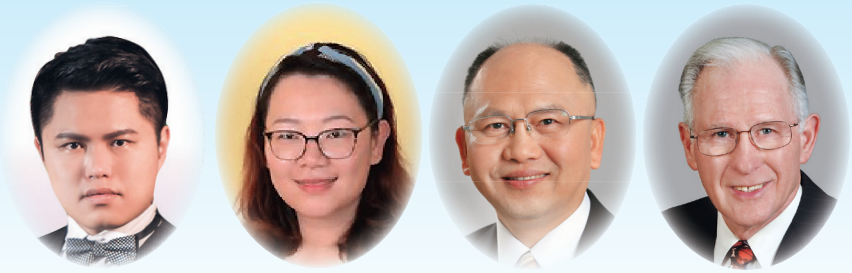

Fig. 1: Pre-treatment facial and intraoral photographs

Introduction

Openbite is a severe problem for both patients and orthodontists. Airway compromise,[1] perioral habits,[2-4] and an unfavorable growth pattern[5] have been associated with open bite malocclusion. Opposing teeth passively erupt (*extrude*) until they contact, unless soft tissue interferes. Thus, the proximal etiology for most openbite malocclusions is aberrant interincisal posture of the tongue and/or lips.[6] Unless the etiology is resolved, functional deviations in soft tissue morphology manifest in childhood[7] may develop into stable malocclusions. Mechanical corrections with conservative orthodontics,[8] cribs,[9] extractions,[10] miniscrew anchorage[11] and/or orthognathic surgery[12,13] tend to relapse unless adequately retained. Although there is broad variance among studies,[8-13] an average of about 75% of openbite corrections are stable because the aberrant soft tissue posture spontaneously corrects when the open bite is closed. However, the residual 25% relapse despite the clinician's best efforts, because the etiology (*soft tissue posture*)[6] failed to resolve spontaneously. For consistent success, it is important to assess the etiology, discuss it with the patient, and plan a course of therapy that specifically addresses the proximal cause of the problem(*s*), if it does not spontaneously correct during treatment. Orofacial myofunctional therapy is an adjunctive approach that may help the patient resolve persistent aberrations in soft tissue posture.[14] It is important to emphasize that openbite is the patient's problem, not the doctor's! The clinician guides the correction of the malocclusion and its etiology, but the patient (*not the doctor*) is responsible for stability. The patient's satisfaction with the outcome of treatment depends on the pretreatment consultation. The patient must assume responsibility for correcting the etiology, often a pernicious habit. Otherwise, an elective treatment for an openbite is a high risk clinical procedure that may negatively impact the reputation of the clinician. Openbite correction is a team effort, and the patient is the star player!

The traditional treatment for skeletal malocclusions is surgical correction of the aberrant morphology, i.e. maxilla and/or mandible are repositioned to achieve ideal proportions.[12,15,16] Orthognathic surgery is expensive, involves considerable risk and morbidity, and furthermore may contribute to functional problems. The relapse rate for overbite corrected with surgery (*average of ~25%*) is about the same as for conservative correction. No matter how the openbite is closed the etiology must be corrected, either spontaneously or therapeutically. The operative and postoperative risks for orthognathic surgery are well known, but the functional sequelae and stability of openbite correction are more obscure. For instance, mandibular set-back surgery for skeletal Class III openbite malocclusion may relapse up to 40%,[17,18] result in neurosensory disturbances,[19] and compromise the airway.[20] The latter is a concern relative to obstructive sleep apnea, particularly in men.[21]

Because of expense, morbidity and instability of orthognathic surgical procedures, conservative alternatives for correcting skeletal Class III openbite malocclusion are of current interest. Bone screws placed lateral to the roots of the molars are effective anchorage for retracting and posteriorly rotating the lower arch.[1,22] The intrusion of the mandibular molars is particularly effective for decreasing the vertical

dimension of occlusion (*VDO*) for skeletal Class III patients with a long, convex face.[23]

Class III malocclusion, particularly with a skeletal basis, is challenging because of a complex diagnosis and uncertain prognosis. After completion of facial growth the traditional treatment options are orthognathic surgery[12,15,16] or camouflage treatment.[24,25] About 92% of adult Class III patients can be treated to a Class I occlusion by orthodontic therapy alone.[26] Camouflage treatment with extractions and Class III elastics usually results in an increase in the ANB angle, VDO, and facial convexity.[27-33] In effect a prognathic mandible is converted into long face.

This case report illustrates the nonsurgical treatment of the adult open bite having a slight prognathic mandible and a full cusp Class III molar relationship. Although the discrepancy index was 103, Lin's 3-ring diagnosis[34] and the Chang et al.[35] extraction chart, indicated this challenging malocclusion could be treated to a normal occlusion with good dentofacial esthetics.

Etiology

Unfortunately the proximal cause of environmental malocclusions is rarely considered in diagnosis and treatment planning. Instead, surgical procedures and mechanics have evolved to correct the morphology to a preconceived norm or standard. Orthodontic correction with or without surgery can be accomplished with many procedures: passive self-ligating (*PSL*) brackets,[1,22] high-pull head-gear therapy,[24,25] extraction treatment,[26,35] multiple-loop edgewise archwires (*MEAW*) mechanics,[36-39] molar intrusion,[40,41] and temporary anchorage devices with elastic traction.[41-43] These techniques can all result in acceptable overjet and overbite, but stability of the correction is uncertain unless the aberrant soft tissue posture is corrected.[6]

Diagnosis

A 27-year-old male presented for orthodontic treatment. His major complaint was no contact of the anterior teeth. Many doctors suggested orthognathic surgery, but that approach was unappealing to the patient. He consulted Beethoven Orthodontic Clinic for a conservative orthodontic solution to manage a 5mm anterior openbite with a bilateral posterior cross-bite. The facial profile was concave, overjet was -5mm, and there was a full-cusp Class III molar relationship, that was about a 10mm discrepancy bilaterally (*Fig. 1*). Dr. Lin's Three-

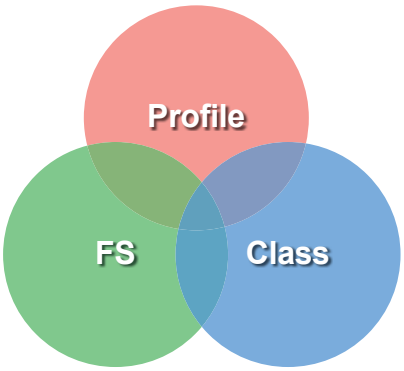

Fig. 2:
Dr. Lin's Three-Ring Diagnosis System assesses the potential for conservative correction of a Class III malocclusion with an anterior crossbite. Favorable factors are:

1. *Profile of the face is acceptable when the mandible is positioned in the centric relation (C_R),*
2. *Class I buccal segments in C_R*
3. *Functional shift (FS) is present from the C_R to centric occlusion C_O.*

Ring Diagnosis System (*Fig. 2*) suggested a good prognosis for conservative correction,[34] and that Chang Decision Making Chart (*Table 1*) indicated the camouflage treatment with extractions was a viable option.

The upper arch was crowded about 5mm, three teeth (*UR3, LL8, LR8*) were missing (*Fig. 3*), but the lower dentition was relatively well aligned (*Figs. 1 and 4*). Cephalometric analysis revealed bimaxillary protrusion (*SNA 83.5˚, SNB 85.5˚*), and an increased mandibular plane angle (*MP 41.5˚*) (*Fig. 5 and Table 2*).

The probable etiology was a childhood airway problem that resulted in low tongue posture and a functional protrusion of the mandible. There was no distress when breathing through the nose with the lips closed. This clinical test suggests the pharyngeal airway problem may have resolved during the adolescent years via a normal recession

	Ext.	Not
1. Profile	Protrusive	Straight
2. Md. angle	High	Low
3. Bite	Open	Deep
4. Ant. inclination	Flaring	Flat
5. Crowding	> 7mm	None
6. Decay/missing	Present	????
7. P't perception	OK	No
8. Etc...		

Table 1:
The Chang's extraction decision making chart helps the clinician to understand the pros and cons related to extracting teeth or not.

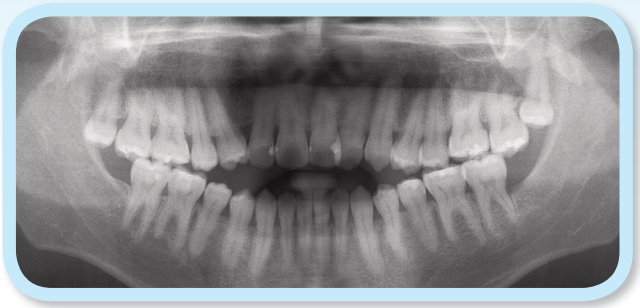

Fig. 3: Pre-treatment panoramic radiograph

Fig. 4: Pre-treatment study models (casts)

Fig. 5: Pre-treatment cephalometric radiograph

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	83°	83°	0°
SNB° (80°)	86°	84°	2°
ANB° (2°)	-3°	-1°	2°
SN-MP° (32°)	42°	44°	2°
FMA° (25°)	35°	37°	0°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	8 mm	4 mm	4 mm
U1 To SN° (104°)	114°	106°	8°
L1 To NB mm (4 mm)	8 mm	2 mm	6 mm
L1 To MP° (90°)	85°	70°	15°
FACIAL ANALYSIS			
E-LINE UL (2-3 mm)	-2.5 mm	-3.5 mm	1 mm
E-LINE LL (1-2 mm)	1.5 mm	-4 mm	5.5 mm
Convexity: G-Sn-Pg' (13°)%	2°	3°	1°
FH: Na-ANS-Gn (53±3%)	60%	60%	0%

Table 2: Pre- and post-treatment cephalometric analysis.

of oropharyngeal lymphoid tissue.[1] Adults with Class III malocclusions can usually be corrected without precipitating an airway problem if there is no distress with nasal respiration pretreatment.

There was crowding in the upper arch. UR3, LL8 and LR8 were missing. The lower dentition was in relatively good alignment (*Fig. 3*). From the cephalometric analysis, the maxilla was normal (*SNA 83.5°*), whereas the mandible was over-grown (*SNB 85.5°*). The mandibular angle was high (*MP 41.5°*).

Treatment Objectives

The treatment objectives were to (*1*) establish functional Class I molar and canine relationship, (*2*) close the anterior open-bite, (*3*) correct the posterior crossbite, (*4*) create ideal overbite and overjet, (*5*) relieve the crowding of the upper anterior teeth, and (*6*) improve facial esthetics.

Treatment Plan

Extract all 1st premolars except the UR4, which will be used for canine substitution. Correct the anterior crossbite with an anterior inclined bite-plate. If further retraction of the lower arch is required, install extra-alveolar bone screws (*2x12mm, OBS®, iNewton Dental Ltd, Hsinchu, Taiwan*) in the buccal shelves bilaterally to serve as anchorage. To correct the posterior crossbite, expand the 0.016x0.025-in stainless steel upper archwire, and utilize bilateral crossbite elastics. Detail and seat the posterior occlusion with vertical elastics as needed. Instruct the patient in the use of the Face Former® (*Dr. Berndsen GmbH Medical, Unna, Germany*) while sleeping to control mouth breathing.[44]

Treatment Alternatives

Option 1. Although two-jaw orthognathic surgery is often indicated for severe Class III openbite malocclusion, the patient refused that option because it was invasive, involved substantial morbidity, required prolonged hospitalization, and would result in substantial medical costs.

Option 2. If the patient had well formed lower 3rd molars bilaterally, extraction of the lower 2nd molars would have been a good choice. Not only would extraction of the L7s help resolve the open-bite, space closure would result in dental alignment over the apical base of bone. Unfortunately both lower third molars were missing, so extractions of L7s was not a viable option.

Option 3. Bilateral mandibular buccal shelf bone screws could be used to retract and distally rotate the entire lower arch. This method substantially decreases the lower facial height to correct severe lip incompetence.[23] However, the patient's lips were only slightly incompetent, so bone screw retraction of the lower arch risked an unfavorable decrease in the vertical dimension of occlusion (*VDO*).

Option 4. Extraction of all first premolars except the UR4 which is substituted for the missing UR3. Utilize both Class III and posterior crossbite elastics. This is a traditional camouflage option that is readily visualized,[10,30] and extractions are a well accepted treatment modality in Taiwan,[35] so the patient preferred this option.

Treatment Progress

The archwire sequence is summarized in Table 3, and the detailed treatment mechanics are outlined in Table 4. Figures 6-10 document treatment progress in the following views: right buccal, frontal, left buccal, upper occlusal and lower occlusal, respectively.

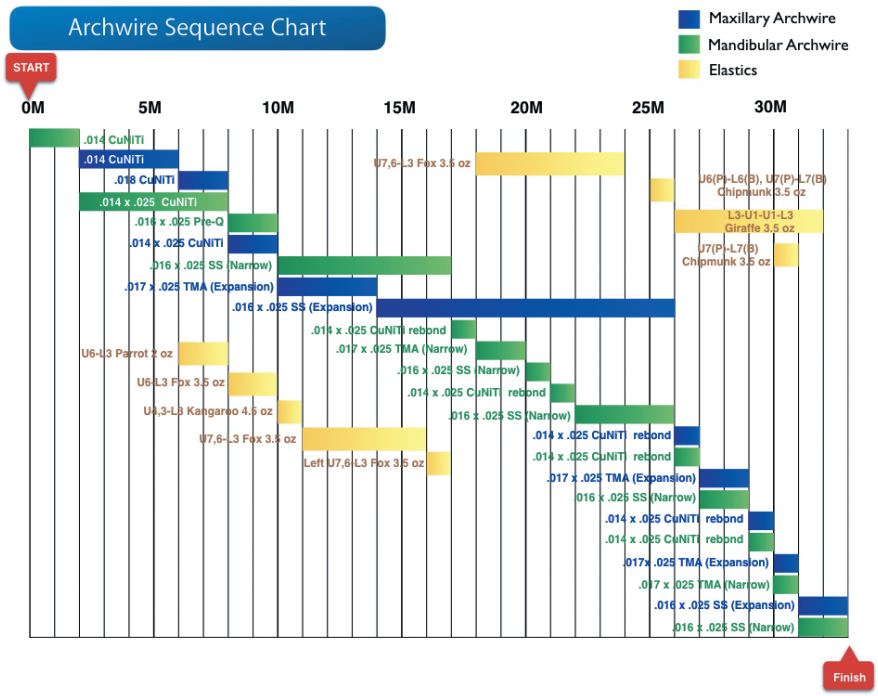

Table 3:
The archwire sequence chart is a treatment timeline for the procedures involved in managing the malocclusion: archwire changes, adjustments, elastics and bracket rebonding procedures. Bracket positions were corrected four times with rebonding procedures. Posterior intermaxillary relationships were corrected with multiple expansion and contraction adjustments.

Appointment	Archwire	Notes
1 (0 months)	L : 0.014-in Damon CuNiTi	Bond all lower teeth. LR4 and LL4 had been extracted. High torque brackets were selected.
2 (1 months)	U: 0.014-in Damon CuNiTi L : 0.014x0.025-in Damon CuNiTi	Bond all upper teeth except UL2. Use the open-coil spring to create space. UL4 had been extracted. Standard Torque brackets were selected for incisors while high torque brackets for canines.
3 (4 months)		Bond UL2 and rebond LL3, LR3 and LR5
4 (6 months)	U: 0.018-in Damon CuNiTi	Started using early light short Class III elastics (Parrot, 5/16-in, 2-oz) from U6s to L3s to retract mandibular anteriors.
5 (8 months)	U: 0.014x0.025-in Damon CuNiTi L : 0.016x0.025-in Damon Pre-Torque CuNiTi	Change the early light short Class III elastics to Fox (1/4-in, 3.5-oz) from U6s to L3s to retract mandibular anteriors.
6 (10 months)	U: 0.017x0.025-in Damon TMA L : 0.016x0.025-in Damon SS	Expand the upper archwire and constrict the lower archwire. Add 15˚ torque to the archwire from LR2-LL2. All the extraction spaces were closed with power chains.
7 (11 months)		All the extraction spaces were closed with power chains. The Class III elastics (Fox, 1/4-in, 3.5-oz) were used from L3s to U6s and U7s to retract the lower anteriors and to protract the upper posteriors.
8 (12 months)		Inclined bite plate on LL1 to guide the UL1 to a normal overjet.
9 (14 months)	U: 0.016x0.025-in Damon SS	Remove the inclined bite plate. Expand the upper archwire and constrict the lower archwire.
10 (16 months)		Continue to close all the space with power chains.
11 (17 months)	L : 0.014x0.025-in Damon CuNiTi	Rebond UR1, LL5, LL7, LR2. Stop elastics.
12 (18 months)	L : 0.017x0.025-in Damon TMA	The Class III elastics (Fox, 1/4-in, 3.5-oz) were used from L3s to U6s and U7s to retract the lower anteriors and to protract the upper posteriors.
13 (20 months)	L : 0.016x0.025-in Damon SS	Continue to expand the upper arch and constrict the lower arch. Close space with the power chains.

■ *Tables 4A and 4B: The treatment sequence for all procedures is outlined in detail.*

Appointment	Archwire	Notes
13 (20 months)	L : 0.016x0.025-in Damon SS	Continue to expand the upper arch and constrict the lower arch. Close space with the power chains.
14 (21 months)	L : 0.014x0.025-in Damon CuNiTi	Rebond LL5, LR1, LR5
15 (22 months)	L : 0.016x0.025-in Damon SS	Continue to expand the upper arch and constrict the lower arch. Close space with the power chains.
16 (24 months)		Bond the buttons on the palatal side of UR6 & UR7, then start crossbite elastics (Chipmunk, 1/8-in, 3.5-oz) to correct the posterior crossbite of the right side.
17 (25 months)		Bond the buttons on the palatal side of UL6 and UL7, then start crossbite elastics (Chipmunk, 1/8-in, 3.5-oz) to correct the posterior crossbite of the left side.
18 (26 months)	U: 0.014x0.025-in Damon CuNiTi L : 0.014x0.025-in Damon CuNiTi	Rebond UR1, UR4, UR5, LL1 to correct axial inclinations.
19 (27 months)	L : 0.017x0.025-in Damon TMA	
20 (28 months)	U: 0.017x0.025-in Damon TMA L : 0.016x0.025-in Damon SS	Use torquing spring to retract the root of the LR1. Bond the buttons on LL5, LL7, LR5, LR7, and hook the power chains to close the space between the posterior teeth.
21 (29 months)	U: 0.014x0.025-in Damon CuNiTi L : 0.014x0.025-in Damon CuNiTi	Interproximal enamel reduction of the upper incisors. Rebond UR1, UR4, LR1.
22 (30 months)	U: 0.017x0.025-in Damon TMA L : 0.017x0.025-in Damon TMA	Add 10˚ buccal crown torque for LL5, LR5 with a 3rd order-bend.
23 (31 months)	U: 0.016x0.025-in Damon SS L : 0.016x0.025-in Damon SS	Consolidation with continuous ligatures from UR5 to UL5 to prevent space opening.
24 (32 months)		Add torque springs to LL5, LR5 for lingual root torque.
25 (33 months)		Cut the archwire of the upper from U3s. Instruct patient to use intermaxillary elastics one by one from the premolars to molars in CIII patency.
26 (33 months & 2 weeks)		All appliances were removed. Fixed retainers were bonded on the lingual surfaces of all maxillary and mandibular incisors. 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 there-after. Instructions were provided for home hygiene and maintenance of the retainers.

■ *Tables 4A and 4B: The treatment sequence for all procedures is outlined in detail.*

Fig. 6: Treatment progression in the right buccal view is shown from the start (0M) to twenty-nine months (29M).

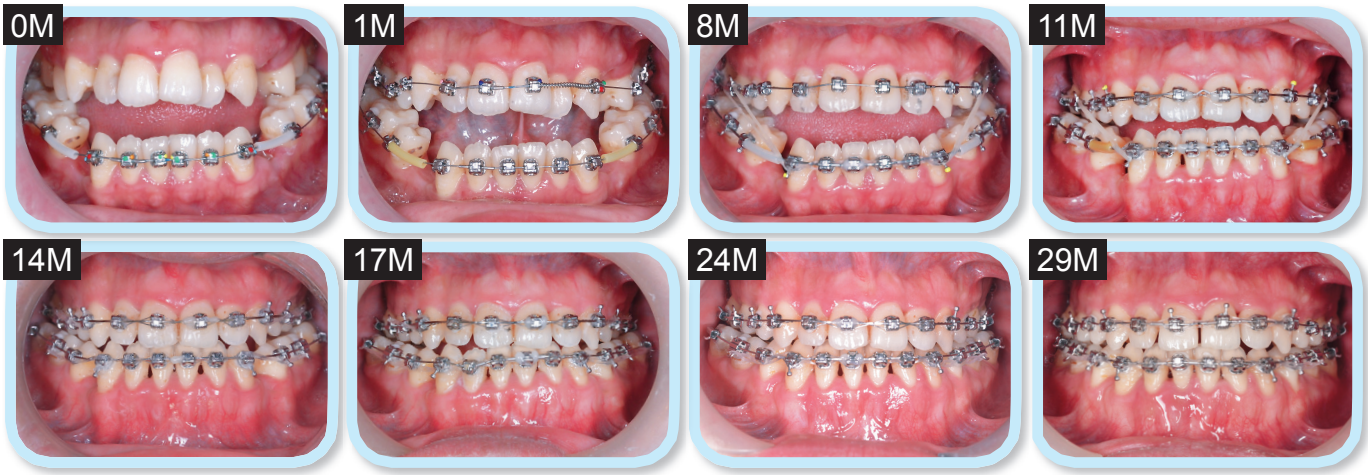

Fig. 7: Treatment progression in the frontal intraoral view is shown form the start (0M) to twenty-nine months (29M).

Fig. 8: Treatment progression in the left buccal view is shown from the start (0M) to twenty-nine months (29M).

Fig. 9: Treatment progression in the maxillary occlusal view is shown from the start (0M) to twenty-nine months (29M).

Fig. 10: Treatment progression from the mandibular occlusal view is shown from the start (0M) to twenty-nine months (29M).

Treatment Results

Both arches were well aligned in an ideal Class I occlusion, with coincident dental midlines (*Figs. 11 and 12*). Overjet was corrected from -5mm to 1mm and the overbite was increased from -5mm to 1mm. The post-treatment panoramic radiograph (*Fig. 13*) shows complete space closure with acceptable root parallelism and no significant periodontal bone loss, but the lower incisors experienced some mild root resorption. The post-treatment cephalometric radiograph documents the dentofacial correction in profile (*Fig. 14*).

Fig. 11: Post-treatment facial and intraoral photographs document 33 months of active treatment. See text for details.

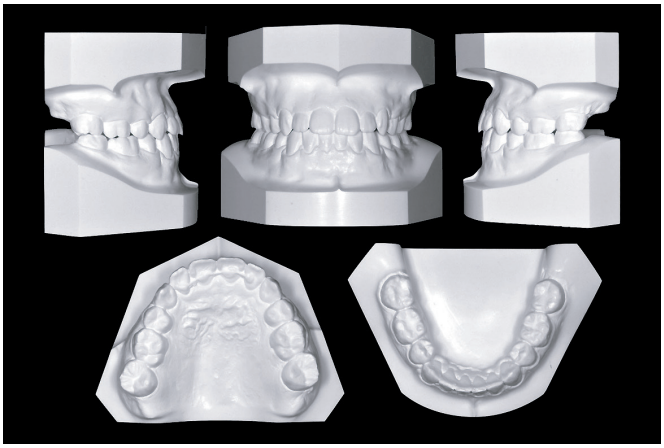

Fig. 12: Post-treatment study models (casts)

Fig. 13: Post-treatment panoramic radiograph

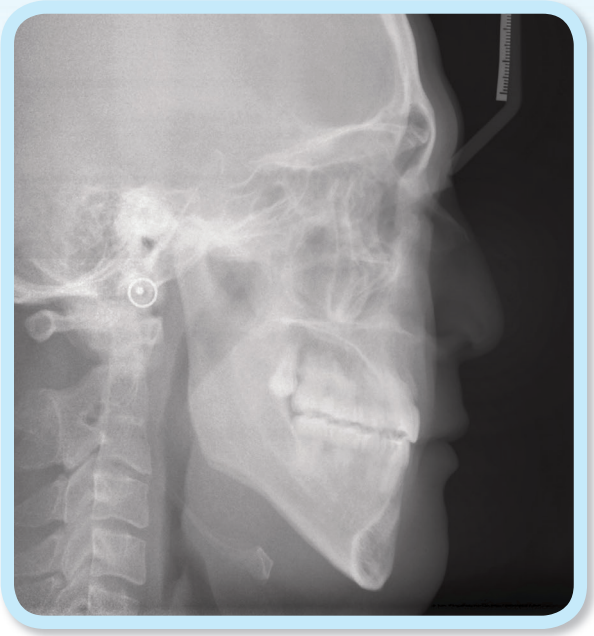

Fig. 14: Post-treatment cephalometric radiograph

Superimposed cephalometric tracings show the uprighting and retraction of the lower molars as well as slight clockwise rotation (*opening*) of the mandibular plane (*Table 2, Fig. 15*). Intermaxillary extrusion and retraction of the incisors corrected the openbite and decreased lip protrusion. The Class III buccal segments were corrected primarily by posterior retraction and distal rotation of the lower arch.

The ABO Cast Radiograph Evaluation score was 22 points, as shown in Supplementary Worksheet 2. The most substantial uncorrected problem was anticipated: buccolingual inclination of the posterior teeth (*11 points*). This compensation is acceptable

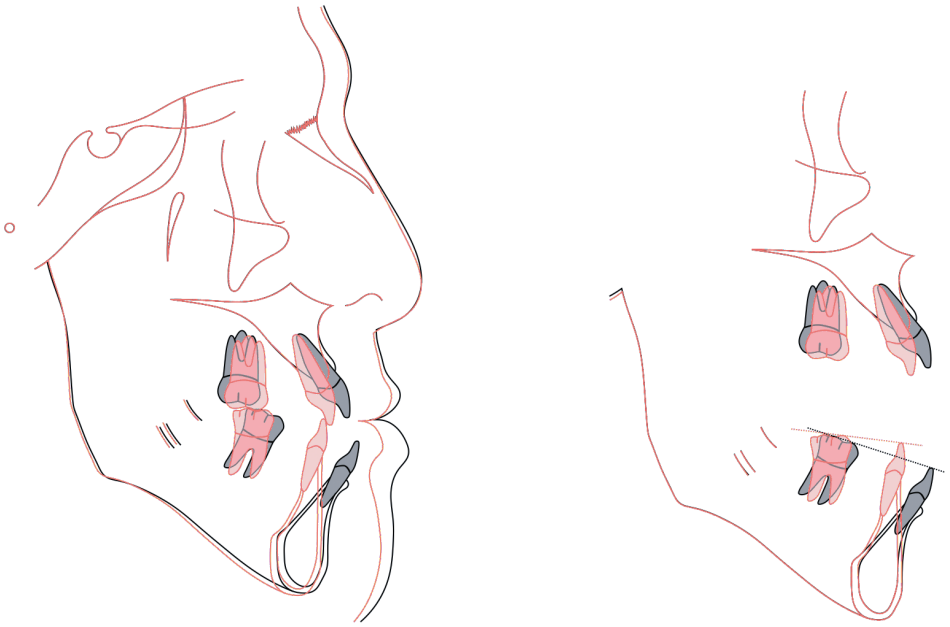

Fig. 15:
Cephalometric tracings are superimposed to show dentofacial changes from the start (black) to the finish (red) of treatment. Superimpositions are on the anterior cranial base (left), maxilla (upper right), and mandible (lower left). See text for interpretation and details of treatment.

for Class III camouflage correction (*Fig. 11*). Dental esthetics were acceptable as documented by the Pink and White dental esthetic index of 4, shown in Supplementary Worksheet 3. The conservative treatment plan required only 33 months of active treatment, and the patient was well pleased with the outcome.

Retention

Fixed retainers were bonded on the lingual surfaces of all maxillary and mandibular incisors. 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 oral hygiene and maintenance of the retainers. The patient was taught how to use the Face Former®[44] while sleeping to control mouth breathing (*Fig. 16*).

Fig. 16:
The patent is shown wearing the neuro-myo-functional training appliance (Face Former®). See text for details.

Discussion

Prevalence of Class III malocclusion ranges from 0.8-4.0% for Caucasians to 12-13% for Chinese and Japanese populations.[45] The etiology of Class III malocclusion may be genetic and/or environmental.[6,46-49] Anterior crossbite is often a function compensation for ectopic eruption of maxillary incisors or anterior posturing of the mandible.[50] Compensations for breathing problems, particularly sleep apnea, are well documented.[51-55] Airway compromise may be compensated by forward posturing of the mandible to achieve increased airway volume.[47,49,50] A low tongue posture, with the tip of the tongue positioned between the teeth, is consistent with openbite.[6,48]

Superimposition of cephalometric tracings (*Fig. 15*) documented extensive tooth movement in both arches. Retraction and counterclockwise rotation of the lower arch was primarily responsible for the correction of the severe (*10mm*) Class III buccal segments. The magnitude of lower arch retraction and posterior rotation was remarkable because no temporary anchorage devices (*TADs*) were used for anchorage. Several aspects of the mechanics contributed to this interesting therapeutic response. First, a PSL appliance can simulate the Class III correction capability of the Multiloop Edgewise Archwire (*MEAW*) technique introduced by Young.[36] It is suggested that this effect is due to 7.0-11.4˚ of play between a 0.019x0.025-in stainless steel wire and the PSL bracket slot (*Fig. 17*). The bracket play is inversely related to archwire size, so small diameter archwires deliver very light 3rd order force, thereby

mimicking the MEAW effect.[28] Second, extraction of lower 1st premolars was necessary to create space for the extensive retraction and the lower anterior teeth. The UL4 was also extracted for symmetry to compensate for the UR3 that was missing at the start of treatment (*Fig. 18*). Space closure in the absence of a compensating gable bend[51] deepens the overbite, which helps close the openbite (*Fig. 15*). Third, Class III elastics tipped the lower molars distally resulting in a counterclockwise rotation of the occlusal plane. This effect on the lower occlusal plane tends to correct Class III openbite malocclusion.[23]

Haas[56] reported that rapid palatal expansion (*RPE*) advances the maxilla, but Wertz et al.[57] found the effect to be limited and unpredictable. RPE may be necessary for some patients with very narrow upper arches, but for most Chinese Class III patients, RPE is not necessary.[58] For the present patient (*Fig. 1*), upper arch width was adequate, and the proximal cause of the Class III openbite was deemed excessive prominence of the mandible (*SNB 86°*). Positioning the casts in a Class I relationship (*Fig. 19*), demonstrated that the maxillary buccal segments

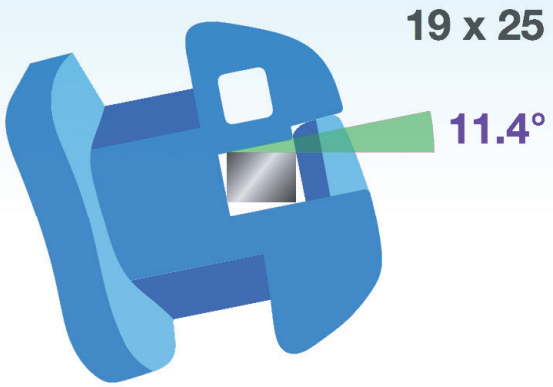

Fig. 17:
A cross-section through a PSL bracket reveals 11.4° of play between the slot and an 0.019x0.025-in archwire. This design is associated with low resistance to sliding mechanics.

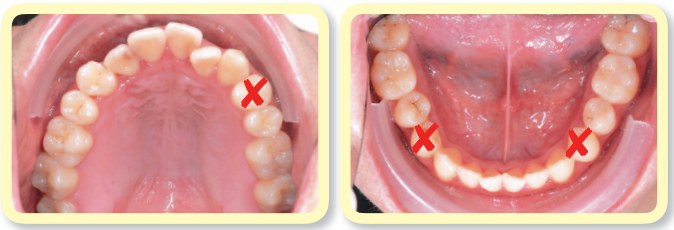

Fig. 18:
Left: *extraction of the UL4 (red X) balances tooth loss bilaterally and provides space for correction of anterior crowding.*
Right: *extraction of both lower 1st premolars provides bilateral space for retraction of the anterior segment.*

Fig. 19:
When the pretreatment study casts (Fig. 4) are positioned in a Class I molar relationship, the relative width of the intermaxillary buccal segments is acceptable, but will require compensation for buccolingual axial inclinations. See text for details.

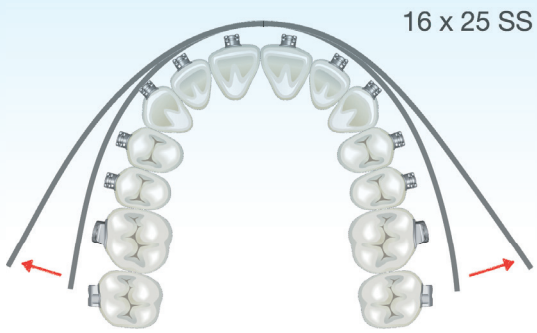

Fig. 20:
Expand a 0.016x0.025-in stainless steel archwire to increase the width of the arch.

Fig. 21:
In 24th month of treatment, buttons were bonded on the lingual surface of the maxillary molars (left) and 3.5-oz cross-elastics were utilized (right).

are of sufficient width to align the dentition, but the final buccolingual alignment (*Figs. 11 and 12*) will probably result in a compromise of buccolingual inclinations, as documented in a CRE score of 11 points. In the 24th month of treatment, the molar relationship was end-on Class III due to the efficiency of lower space closure. Arch width correction required expansion of the upper 0.016x0.025-in stainless steel archwire (*Fig. 20*), and use cross elastics in the posterior segments for several months (*Fig. 21*). The buccolingual compromise of the upper and lower posterior segments was an acceptable compromised outcome (*Fig. 11*).

Class III elastics and bilateral space closure produced the expected lingual tipping of the lower anterior segment. Low torque brackets were inverted on the lower incisors to produce high torque performance (*Fig. 22, left*). In the leveling and alignment stages, 0.016x0.025-in pre-torque CuNiTi was used to increase the incisal torque. When the archwire was changed to 0.016x0.025-in stainless steel for

Fig. 22:
Selection of bracket torque for the anterior teeth:

Left: *Inverted low-torque brackets deliver substantial lingual root torque (7-11˚) that results in super high-torque performance.*

Center: *Standard torque brackets (6-15˚) are adequate for the maxillary anterior segment.*

Right: *Class III elastics produce counterclockwise moments around the center of rotation (blue dot with a black pus sign) in both arches that tends to flare maxillary incisors, and tip mandibular incisors lingually. These undesirable incisor effects are prevented with incisor brackets that have normal lingual root torque in the maxilla and increased lingual root torque in the mandible. SQ is the moderating effect of standard torque. HQ is the lower incisor uprighting effect of high torque brackets.*

space closure mechanics, about 15˚ of lingual root torque was lost (*Table 2*). For the upper incisors, standard torque brackets were adequate to maintain lingual root torque because of the crowded arch. Most of the UL4 space was utilized for correcting crowding so the post-treatment axial inclination of the maxillary incisors was adequate (*U1-SN: 106˚*) as shown in Fig. 22 (*center and right image*) and Table 2.

Anterior openbite is typically associated with interincisal digit (*finger or thumb*) as well as soft tissue (*tongue or lip*) posture.[6,55] Extreme dentoalveolar compensation for treatment of skeletal Class III malocclusion[59] is successful for correction of openbite if the interincisal soft tissue posture corrects spontaneously.[6,55] To paraphrase Harold Frost,[60] "*conventional wisdom*" holds that transient mouth breathing and tongue thrusting are the etiology of anterior openbite. This conclusion is suspect because only continuous loads move teeth.[6,56,61] In any event, it is important to control mouth breathing because the aberrant tongue and mandibular posture to open the airway is associated with low tongue posture and an interincisal position of soft tissue (*lips and/or tongue*). The latter is the proximal etiology of openbite and not the former. Tongue thrusting is actually a response to openbite, not the cause of it, because it is impossible to swallow without an anterior tongue seal of the oral cavity.[6,56] It is important to control mouth breathing so that the aberrant soft tissue posture can be corrected, but the tongue thrusting usually corrects spontaneously once the openbite is closed. The FaceFormer® appliance, developed by Dr. Klaus and Sabine Berndsen,[44] helps stabilize the transient functions of the oral pharyngeal region that are associated with a patent airway, as well as normal head and neck posture. The patient was instructed to perform FaceFormer® training 3 times a day. There were 20 basic exercises together plus 20 pulling exercises to strengthen the lip-seal. Also, the patient was instructed to wear the device when sleeping to reinforce nasal breathing. To establish new posture and motion patterns that will be stable, the patient was instructed to perform the exercises and wear the device at night for at least 6 months.

Orthodontists should carefully evaluate skeletal Class III malocclusion because the discrepancy may have a longterm etiology related to breathing. The airway may be compromised early in infancy, particularly when sleeping. If an infant is unable to open the airway by reflex posturing of the mandible anteriorly and/or lowering tongue posture, the problem may result in sudden infant death syndrome (*SIDS*).[62] A skeletal Class III malocclusion may be the sequelae of mandibular and tongue posturing to maintain a patent airway. The habit often begins in infancy and is reinforced in childhood by hypertrophy of pharyngeal lymphoid tissue.[1] Although the pharyngeal airway improves during adolescence as the lymphoid tissue atrophies, the abnormal posturing of the mandible and soft tissue is an acquired habit that does not spontaneously correct. The critical diagnostic test for a skeletal Class III malocclusion is to assess nasal respiration with the mouth closed. If normal breathing through the nose with the mouth closed is a problem, an otolaryngology consult is indicated. Persistent airway problems for Class III patients are more common for

females,[63] but post-treatment sleep apnea is more of a concern for men.[20] However, most skeletal Class III patients can be corrected without developing airway problems or sleep apnea.[64] If a patient has no problems with nasal respiration, the malocclusion can usually be conservatively corrected and the airway postural problems will spontaneously resolve for about 75% of patients. For the 25% that maintain low tongue posture and/or an anterior openbite, habit correction therapy is indicated. Conservative treatment for the present skeletal Class III openbite patient resulted in spontaneous correction of the airway-related habits, so no additional therapy was required.

Conclusions

Skeletal CIII openbite malocclusion is a complex problem that requires a careful evaluation. Lin's three ring diagnosis is useful for determining if the problem can be managed conservatively. If a camouflage approach is feasible, Chang's extraction table is helpful for formulating a viable treatment plan. For the present patient, retraction and posterior rotation of the lower arch was a critical factor for managing severe skeletal malocclusion conservatively, i.e. without resorting to orthognathic surgery or TADs. A PSL bracket system achieved a MEAW effect that facilitated closure of the anterior openbite. Specific torque selection of the lower incisor brackets and a pretorqued archwire offset the severe distal tipping of lower incisors that was anticipated with space closure and Class III elastics.

Acknowledgment

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 103

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 = 21

OVERBITE

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

Total = 0

ANTERIOR OPEN BITE

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

Total = 29

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 4

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 = 4

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 = 18

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 8

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° 1 x 1 pt. = 1

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

SN-MP

≥ 38° = 2 pts.

Each degree > 38° 4 x 2 pts. = 8

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 15

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. =	2
Missing teeth (except 3rd molars)	1 x 1 pts. =	1
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	_____ x 2 pts. =	_____

Identify:

Total = 4

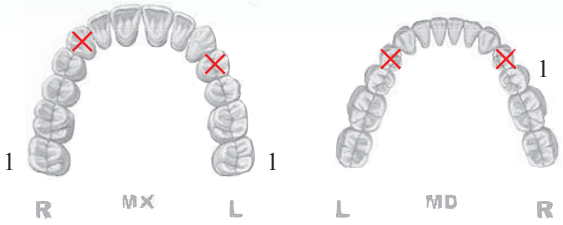
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 22

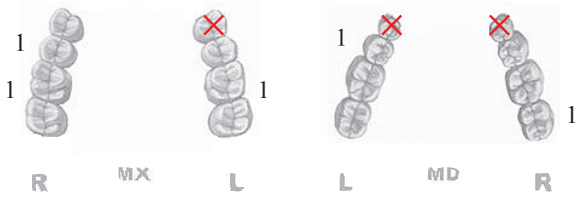
Alignment/Rotations

3



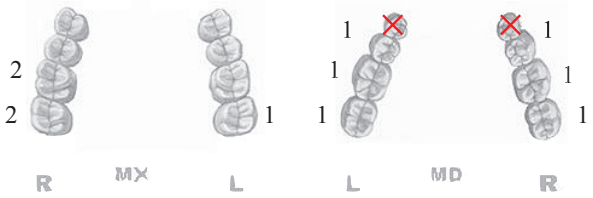
Marginal Ridges

5



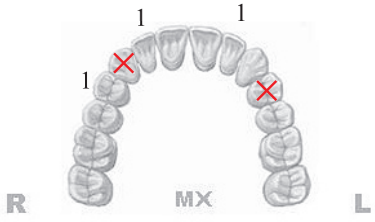
Buccolingual Inclination

11



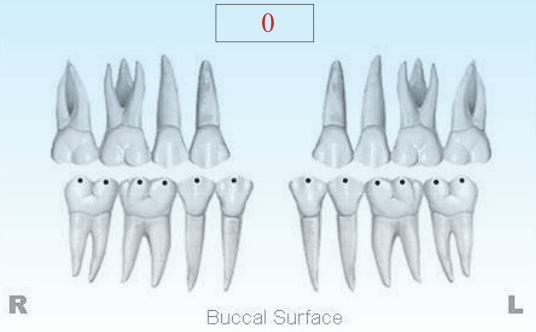
Overjet

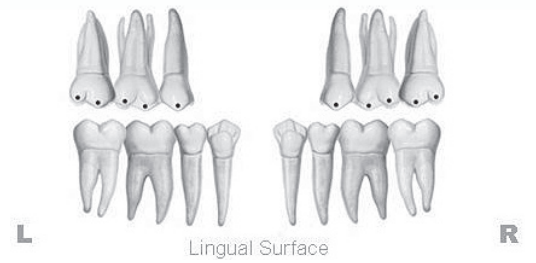
3



Occlusal Contacts

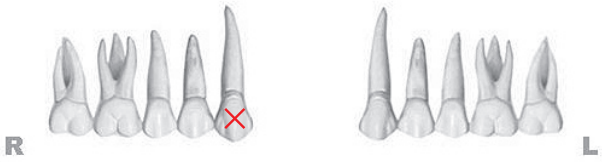
0





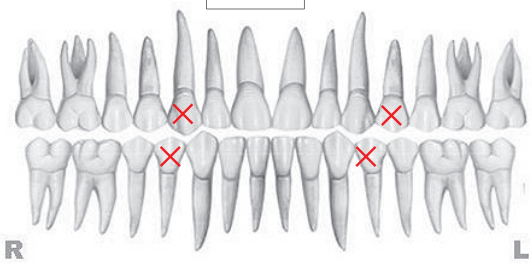
Occlusal Relationships

0



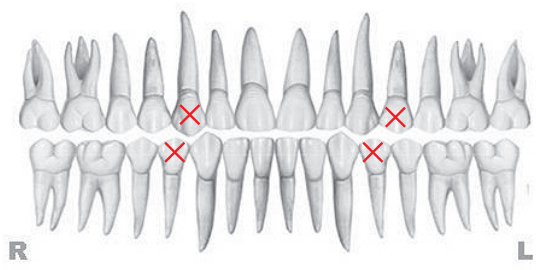
Interproximal Contacts

0



Root Angulation

0



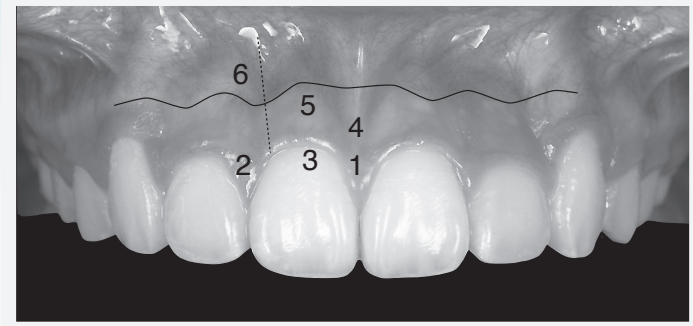
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 4

1. Pink Esthetic Score

Total = 1

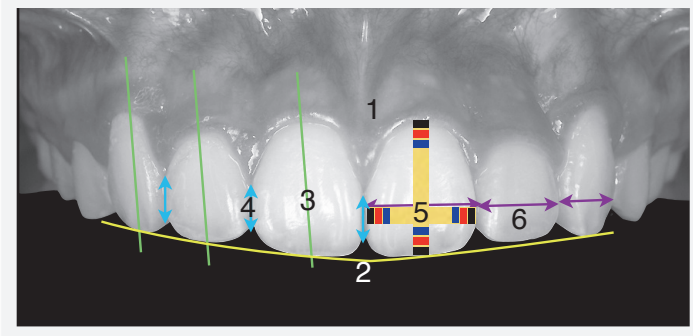


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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

2. White Esthetic Score (for Micro-esthetics)

Total = 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