Conservative Treatment of Severe Malocclusion in a 15y5m Nongrowing Female: Growth-like Skeletal Adaptation 3 Years Later

Abstract

***Introduction**: A 15y5m post-menarche female presented with a severe skeletal Class II, crowded malocclusion: ANB 7º, FMA 37º, discrepancy index (DI) 41, and buccal crossbite of the upper right first premolar (#5). Conservative treatment with no extractions or orthognathic surgery was requested.*

***Methods**: After a careful discussion of potential risks in a potentially nongrowing patient, the family opted for fixed appliance treatment with passive self-ligating brackets, bite turbos, intermaxillary elastics, and extra-alveolar bone screws anchorage to differentially retract both arches.*

***Results**: With only 20 months of active treatment, an acceptable result was achieved: good facial form, lip competence, and cast-radiograph evaluation (CRE) of 28 points. The only concern was a 1-2° increase in the mandibular plane, which was attributed to the posterior bite turbos, used to correct the posterior buccal crossbite. The patient was fitted with lower 3-3 fixed and upper clear overlay retainers. Follow-up records 3 years later revealed an improvement in dental alignment (CRE decreased from 28 to 20). There was also a downward and forward, growth-like response of the mandible, which appears to be a favorable skeletal adaptation to optimized stomatognathic function.*

***Conclusions**: Conservative correction of severe skeletal malocclusion resulted in a favorable dentofacial adaptation that is consistent with the ability of the face to adapt to environmental factors over a lifetime. (Int J Orthod Implantol 2016;41:22-38)*

Key words:
Self-ligating appliance, bite turbo, bone screws, conservative treatment, long-term follow-up, skeletal adaptation

History and Etiology

A 15-year-5-month-old postmenarche female presented with a severely crowded, asymmetric Class II malocclusion (*Figs. 1-3*). Despite her challenging malocclusion (*DI 41*), a slight facial convexity (*13º facial angle*) was within normal limits (*WNL*). Both the medical and dental history were non-contributory, and there was no evidence of contributing oral habits or temporomandibular dysfunction. The patient was treated to a pleasing result, as shown in Figs. 4-9.

Diagnosis

Skeletal:

- Skeletal Class II (*SNA 81°, SNB 74°, ANB 7°*)
- High mandibular plane angle (*SN-MP 44°, FMA 37°*)
- Condylar heads were symmetric in length (*Fig. 10*)

Dental:

- The maxillary dental midline was shifted 2 mm to the left of the facial midline.

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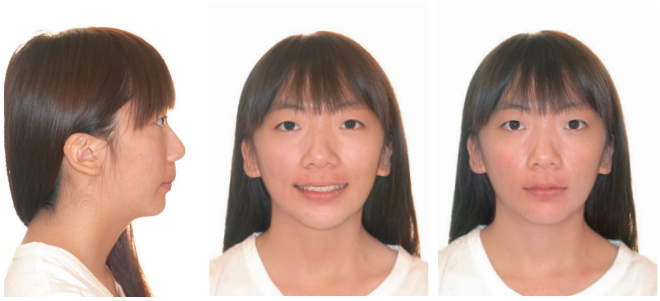
■ *Fig. 1: Pre-treatment facial photographs*



■ *Fig. 4: Post-treatment facial photographs*

■ *Fig. 2: Pre-treatment intraoral photographs reveal severe crowding*

■ *Fig. 5: Post-treatment intraoral photographs*

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

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

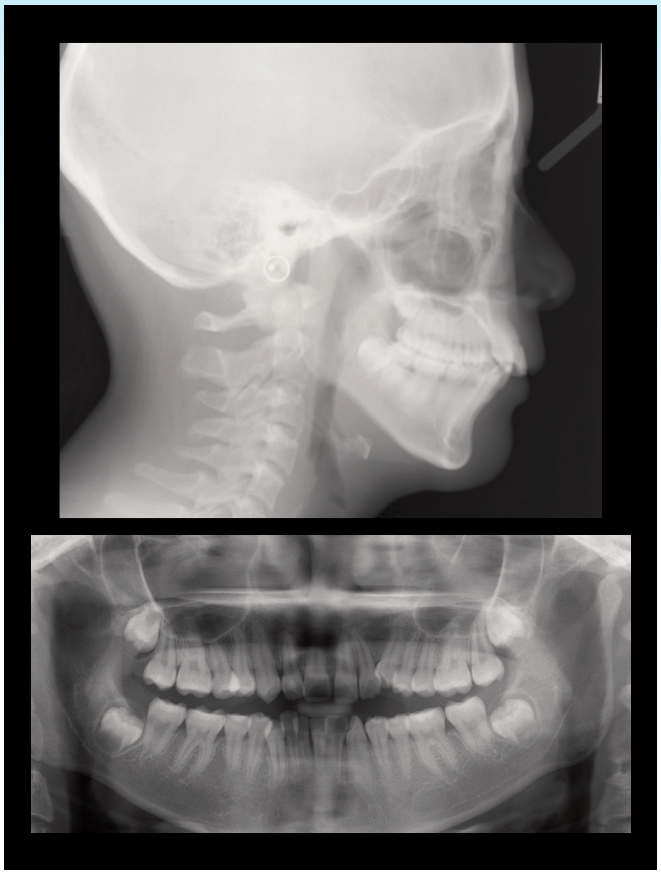


Fig. 7:
Pre-treatment cephalometric and panoramic radiographs

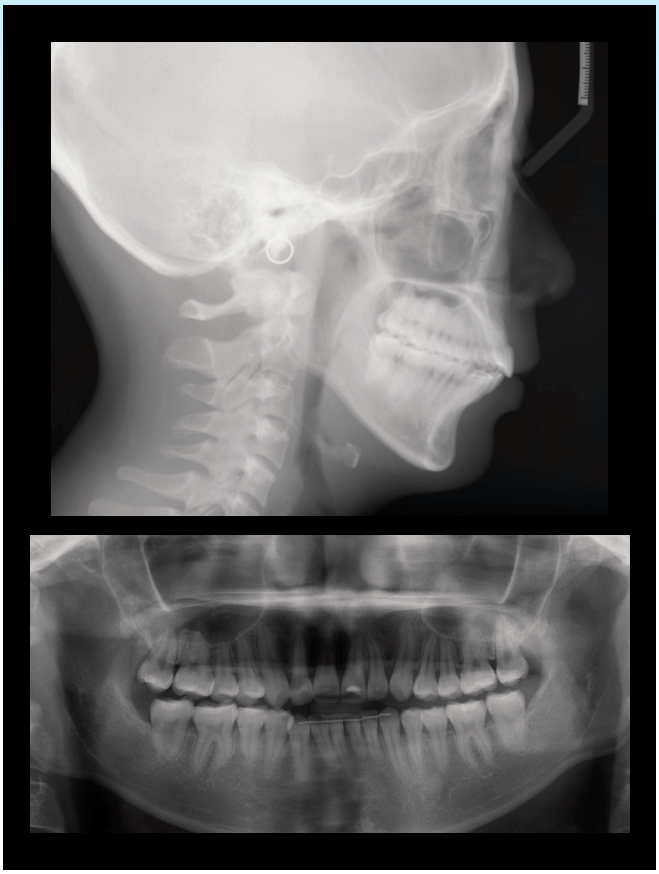


Fig. 8:
Post-treatment cephalometric and panoramic radiographs

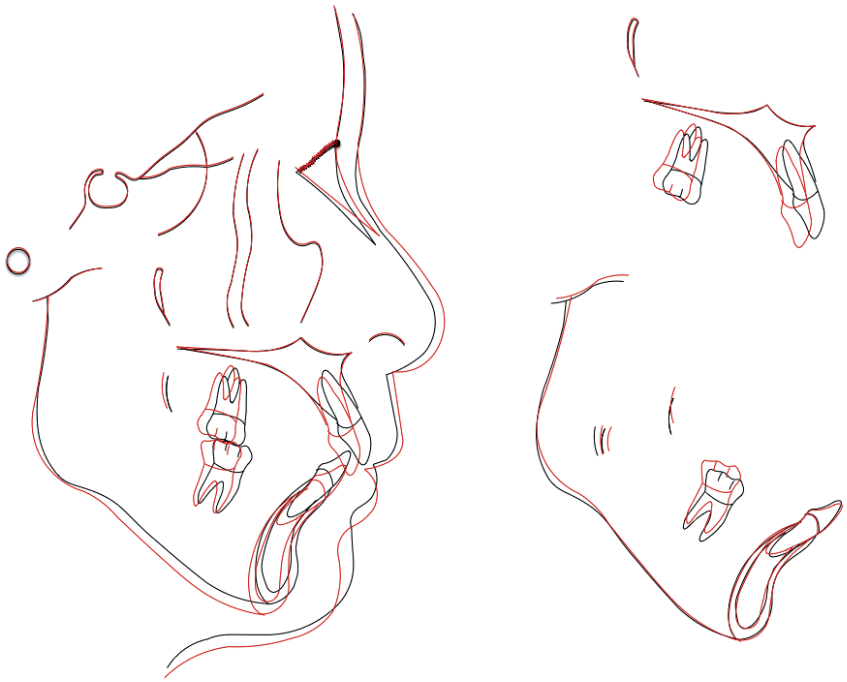


Fig. 9:
Superimposed tracings of the pre-treatment (black) and post-treatment (red) cephalometric radiographs show the dental and skeletal changes during treatment. See text for details.

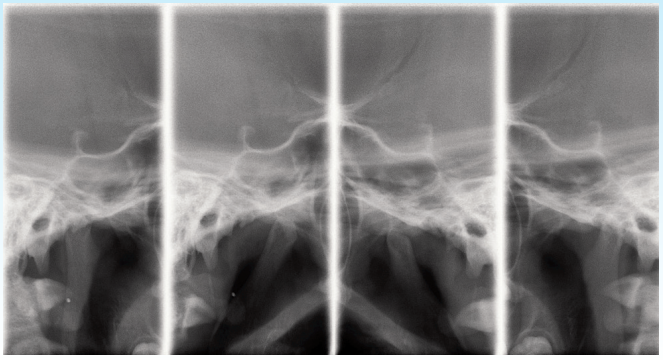


Fig. 10:
The morphology for the condyle heads of the mandible were symmetrical.

- Bilateral Class II molar and canine relationships
- 5 mm space deficiency for the upper arch and 8 mm deficiency for the lower arch
- Maxillary right first premolar (#5) in buccal crossbite

Facial:

- Slightly convex profile (13° *facial angle*) was WNL
- Facial symmetry
- Acceptable incisal exposure when smiling

The American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) was 41 as shown in the subsequent worksheet.

Specific Objectives of Treatment

Treatment objectives were: 1. correct the maxillary and mandibular crowding, 2. retract the dentition in both arches, 3. achieve ideal overjet and overbite, 4. resolve intermaxillary sagittal and frontal discrepancies, and 5. achieve an excellent dentofacial finish with an ABO cast radiograph score (*CRE*) of no more than 30 points.

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

- A - P: *Maintain*
- Vertical: *Minimize opening with the bite turbos to correct the #5 buccal crossbite*
- Transverse: *Maintain*

Maxillary Dentition:

- A - P: *Retract incisors and tip-back molars*
- Vertical: *Maintain*
- Inter-molar / Inter-canine Width: *Alignment over the apical base of bone*

Mandibular Dentition:

- A - P: *Maintain*
- Vertical: *Maintain*
- Inter-molar / Inter-canine Width: *Alignment over the apical base of bone*

Facial Esthetics:

- Maintain

Treatment Plan

For informed consent, two treatment plans were offered.

Option A: Correct crowding by extracting bilateral upper first premolars and lower second premolars (*Fig. 11*).

Option B: Because of the severe crowding, non-extraction treatment would probably require an OrthoBoneScrew® (*OBS*) (*2x12mm, Newton's A Ltd, Hsinchu, Taiwan*)[1] on the buccal surface of each first molar to retract both arches. This method is deemed extra-alveolar (*E-A*) OBS anchorage. Extraction of all

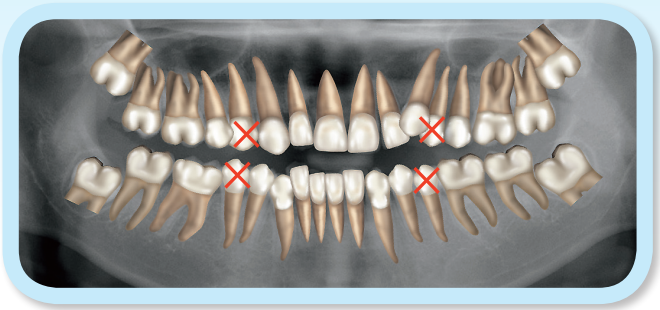


Fig. 11:
Option A: Extraction of upper 1st and lower 2nd premolars (#5, 12, 20, 29)

Fig. 12:
Option B: Correct crowding by retracting all four buccal segments with OrthoBoneScrew® anchorage.

third molars is indicated if the arches are retracted (*Fig. 12*).

The patient and her family were informed about the pros and cons of each approach, and Option B was selected.

Appliances and Treatment Progress

An .022" slot Damon Q® bracket system (*Ormco, Glendale, CA*) was selected. Low torque brackets were bonded on the maxillary and mandibular anterior teeth to resist the tendency toward bimaxillary protrusion as the crowding was corrected. The intraoral treatment sequence is

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	81°	80°	1°
SNB°	74°	73°	1°
ANB°	7°	7°	0°
SN-MP°	44°	46°	2°
FMA°	37°	39°	2°
DENTAL ANALYSIS			
U1 TO NA mm	5 mm	2 mm	3 mm
U1 TO SN°	102°	97°	5°
L1 TO NB mm	10 mm	10 mm	0 mm
L1 TO MP°	101°	102°	1°
FACIAL ANALYSIS			
E-LINE UL	-1 mm	1 mm	2 mm
E-LINE LL	-1.5 mm	0 mm	1.5 mm

Table 1: Cephalometric summary

illustrated in Figs. 13 and 14. Both arches were bonded and aligned with the following archwire sequence: .014" CuNiTi, .014x.025" CuNiTi, and .017x.025" TMA. To correct the buccal crossbite of the maxillary right 1st premolar (#5), a button was bonded on the lingual surface of the mandibular right 1st premolar (#28), for a cross elastic to be used between #5 and #28. Bite turbos, were constructed with Fuji II® type II glass ionomer cement (*GC America, Alsip, IL*) on the occlusal surfaces of both mandibular 1st molars (*#19 & 30*) to open the bite for the correction of #5 buccal crossbite (*Fig. 13*). Bite turbos facilitated the crossbite correction but at the risk of increasing the overjet as the mandible rotated posteriorly. During the course of the treatment, Class II elastics were upgraded from 2 to 4.5oz to resolve the enhanced overjet which

Fig. 13:

***Cross Bite Correction**: a button was bonded on the lingual surface of #28, and a cross elastic was used from the buccal bracket on #5 to the lingual of #28.*

***Bite turbos**: were placed on the occlusal surfaces of both lower first molars to open the bite and avoid the occlusal interference blocking the correction of #5 buccal crossbite.*

was probably a factor in increasing the mandibular plane angle, as noted in Fig. 9.

In the 5th month of treatment, the crowding was relieved and the crossbite was corrected, but there was a bimaxillary protrusion, loss of lip competence and anterior open bite (*Fig. 14*). Supplemental anchorage was clearly necessary, so four 2x12mm OBSs were installed bilaterally in the maxillary infrazygomatic crests and mandibular buccal shelves. Elastic chains were stretched between the miniscrews and the respective canines bilaterally. The four OBSs served as anchorage to retract and control the protrusion of both arches.

In the 9th month, the en masse retraction of the upper dentition resulted in the infrazygomatic crest OBSs contacting the hooks on the upper molar brackets. The latter were removed with a high speed diamond bur to continue retraction of the dentition (*Fig. 15*).

In the 12th month, .017x.025" TMA archwires were placed and a figure-8 ligature was tied between upper 3-3 to maintain firm contact, and the bite turbos were removed. At 15 months the lower second molars were retracted into the retromolar soft tissue (*Fig. 16*).

In the 17th month, a 1 mm maxillary midline shift to the right side was noted. Elastics (*Bear 1/4" 4.5 oz*) were applied from the upper right canine (*#6*)

Fig. 14:
In reference to the initial malocclusion (0M), the #5 crossbite was corrected after 5 months of treatment (5M). However, bimaxillary protrusion and an anterior open bite were noted.

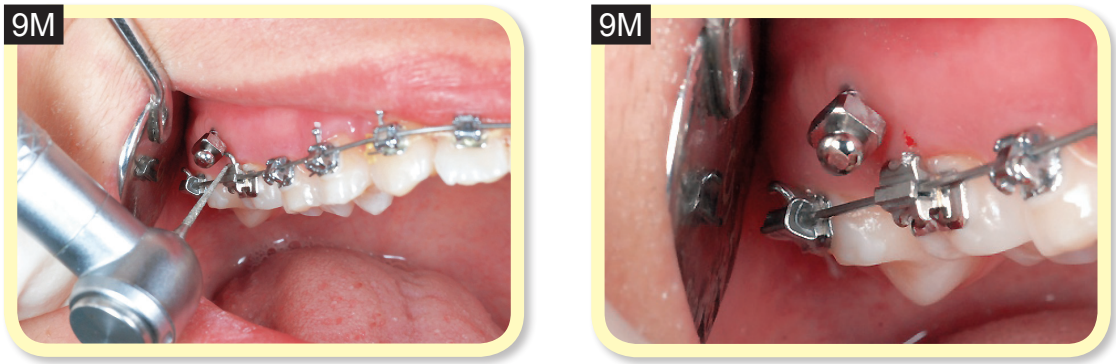


Fig. 15:
In the 9th month, the en masse retraction of the upper dentition caused the infrazygomatic OrthoBoneScrews to hit the upper molar bracket hooks. The hooks were removed with a high speed diamond bur to facilitate further retraction.

Fig. 16:
The space between the terminal molar and the external oblique ridge of the ascending ramus of the mandible limits the distance that the entire arch can be retracted.

to the lower left canine (#*22*), and from the upper left canine (#*11*) to the lower left 1st molar (#*19*) to detail the occlusion (*Fig. 17*). Because of inadequate retromolar space, all four 3rd molars were extracted in the 19th month of treatment.

Bracket repositioning was performed repeatedly as indicated by the sequential panoramic films. Wire bending was performed for detailing the occlusion during the final stages of the treatment. One month before the completion of the active treatment, the upper archwire was sectioned distally to the cuspids, and vertical (*up and down*) elastics were used for 2

Fig. 17:
At 18 months (18M) elastics (Bear ¼" 4.5oz) were applied from the upper right canine (#6) to lower left canine (#22), and from upper left canine (#11) to lower left 1st molar (#19). By 20 months (20M) the midline was corrected.

weeks to improve the articulation of the posterior teeth (*Fig. 18*).[2] After 20 months of active treatment, the appliances were removed.

Results Achieved

Maxilla (*all three planes*):

- A - P: *A point retracted*
- Vertical: *Maintained*
- Transverse: *Maintained*

Mandible (*all three planes*):

- A - P: *Retracted*
- Vertical: *Increased mandibular plane angle due to posterior rotation*
- Transverse: *Maintained*

Fig. 18:
One month before the completion of active treatment, the upper archwire was sectioned distal to the cuspids, and up and down elastics (2oz) were used for 2 to 3 weeks to improve the articulation of the posterior teeth.[2]

Maxillary Dentition

- A - P: *Anterior incisors were retracted and molars were tipped distally*
- Vertical: *Incisors extruded*
- Inter-molar / Inter-canine Width: *Slight expansion*

Mandibular Dentition

- A - P: *Molars retracted (tipped distally)*
- Vertical: *Molars extruded*
- Inter-molar / Inter-canine Width: *Slight expansion*

Facial Esthetics: More convex with increased lower facial height, lip protrusion WNL

Retention

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

Final Evaluation of the Treatment

Cephalometric analysis (*Table 1*), superimpositions (*Fig. 9*), and a cephalometric sequence (*Fig. 19*) show that the upper incisors and molars in both arches were retracted. The mandible was rotated posteriorly, resulting a 1-2° increase in the mandibular plane angle, and there was a 1° reduction in the SNA and SNB angles. The upper incisor to SN angle was decreased from 102° to 97°. The angle of the lower incisor to the mandibular plane was increased from 101° to 102°. Although lower facial height increased, photographs (*Fig. 4*) and cephalometric films (*Fig. 8*) after treatment are consistent with maintaining lip competence, which is an important objective for nonextraction alignment of crowding (*Fig. 19*).

The ABO Cast-Radiograph Evaluation (*CRE*) score was 28 points. The major discrepancies were marginal ridges (*8 points*), occlusal relationships (*6 points*), overjet (*5 points*), and alignment/rotations (*5 points*). Overall, the dentition was well aligned and the midlines were corrected. Although the facial profile was slightly more convex (*Fig. 20*), the lip protrusion was reduced, and the patient was satisfied with the result.

Discussion

Malocclusions with severe crowding usually require premolar extraction, but the current patient was opposed to any extractions except third molars. Nonextraction treatment presents a number of physiologic and esthetic challenges. To avoid incisal flaring and an unesthetic bimaxillary protrusion, there are three important biomechanics issues:

1. Bracket selection

Torque: Low torque anterior brackets were used in both arches to control incisal flaring during alignment, because that is more efficent than placing torque in the archwires.

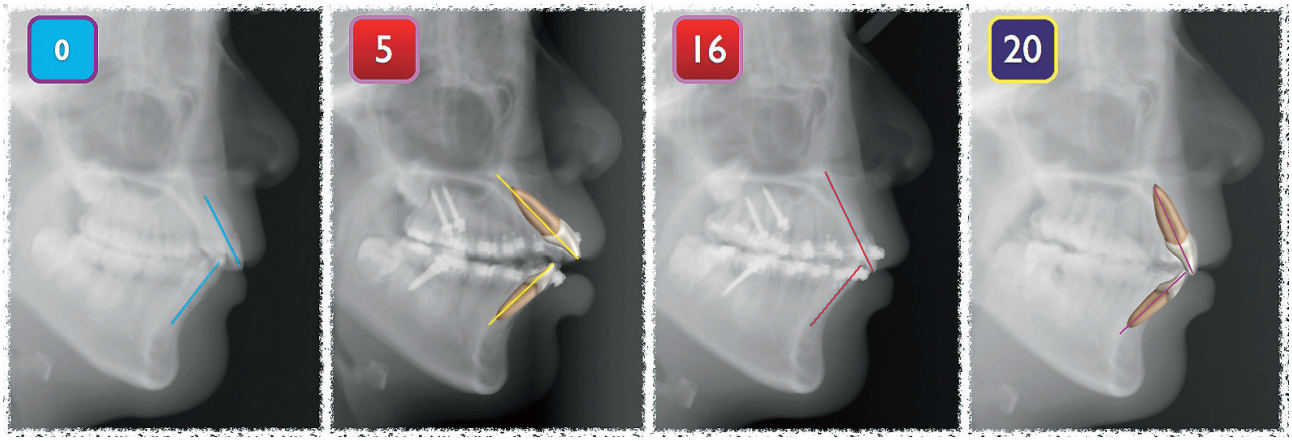


Fig. 19:
At the start of treatment (0) the axial inclinations are marked with blue lines. At five months (5) it was clear that bimaxillary protrusion was occurring so bilateral E-A miniscrews were placed lateral to the first molars in both arches. By sixteen months (16) the bimaxillary protrusion was reduced, and at twenty months (20) the final result was achieved. Note the near ideal facial profile and lip protrusion at end of active treatment.

Position: The bonding protocols for nonextraction treatment were developed based on the recommendations of Pitts,[3] as modified by Chang and Roberts[4] to compensate for tipping when retracting buccal segments. For example, the posttreatment panoramic radiograph (*Fig. 8*), reveals distal tipping of the the lower right first molar (#*30*). This problem was due to inadequate counterclockwise rotation of the bracket, when #30 was bonded.

2. Bite turbos and vertical control

Bite turbos constructed with Fuji II® type II glass ionomer cement on posterior occlusal or anterior palatal surfaces are useful for opening the interocclusal space to correct crossbites and to facilitate leveling.[5] Posterior bite turbos prevent extrusion of buccal segments, but the bite opening rotates the mandible posteriorly (*Fig. 9*), creating more overjet and potential extrusion of the incisors. Correcting the large overjet, requires extended use of Class II elastics, which extrudes and retracts the maxillary incisors, extrudes lower molars, and increases the axial inclination of the mandibular incisors. In retrospect, posterior rotation of the mandible may have been prevented by controlling the extrusion of the maxillary incisors by the simultaneous use of anterior and posterior bite turbos during the crossbite correction. A biomechanics option for simultaneously controlling retraction and intrusion of incisors is an overlay 3-piece base arch.[6] If the extrusion of the maxillary incisors is prevented, the lower buccal segments can be intruded with the E-A OBS anchorage, thereby preventing or at least recovering the increase in the mandibular plane angle (*Fig. 9*).

3. Extra-Alveolar OrthoBoneScrew (E-A OBS) Anchorage

Temporary anchorage devices (*TADs*),[7] peripheral to the alveolar arch, provide stable anchorage[8] for increasing arch length to correct crowding.[9]

Fig. 20: The facial profile is shown at 0, 5, 15, and 20 months.

Furthermore, they can serve as skeletal anchorage for en masse retraction of entire arches.[10-12] The limitation for retraction of the buccal segments is the amount of retromolar space. In the lower arch, this is the space between the terminal molar and the external oblique ridge of the ascending ramus. In the maxilla, the tuberosity limits the distance that the entire arch can be retracted (*Fig. 19*).

Cephalometric analysis (*Table 1*) indicated a slight increase in protrusion at the end of treatment. This was a pleasing result (*Fig. 20*) considering there was a transient increase in protrusion and lip incompetence as the severe crowding was corrected (*Fig. 19*). Lip protrusion and competence were controlled by retracting both arches with anchorage provided by the E-A bone screws.

In the 17th month of treatment, the timing for extraction of the third molars was coordinated to the correction of the midline, because the localized bone remodeling rate is elevated, thereby facilitating tooth movement.[13] This burst of bone remodeling is deemed the regional acceleratory phenomenon

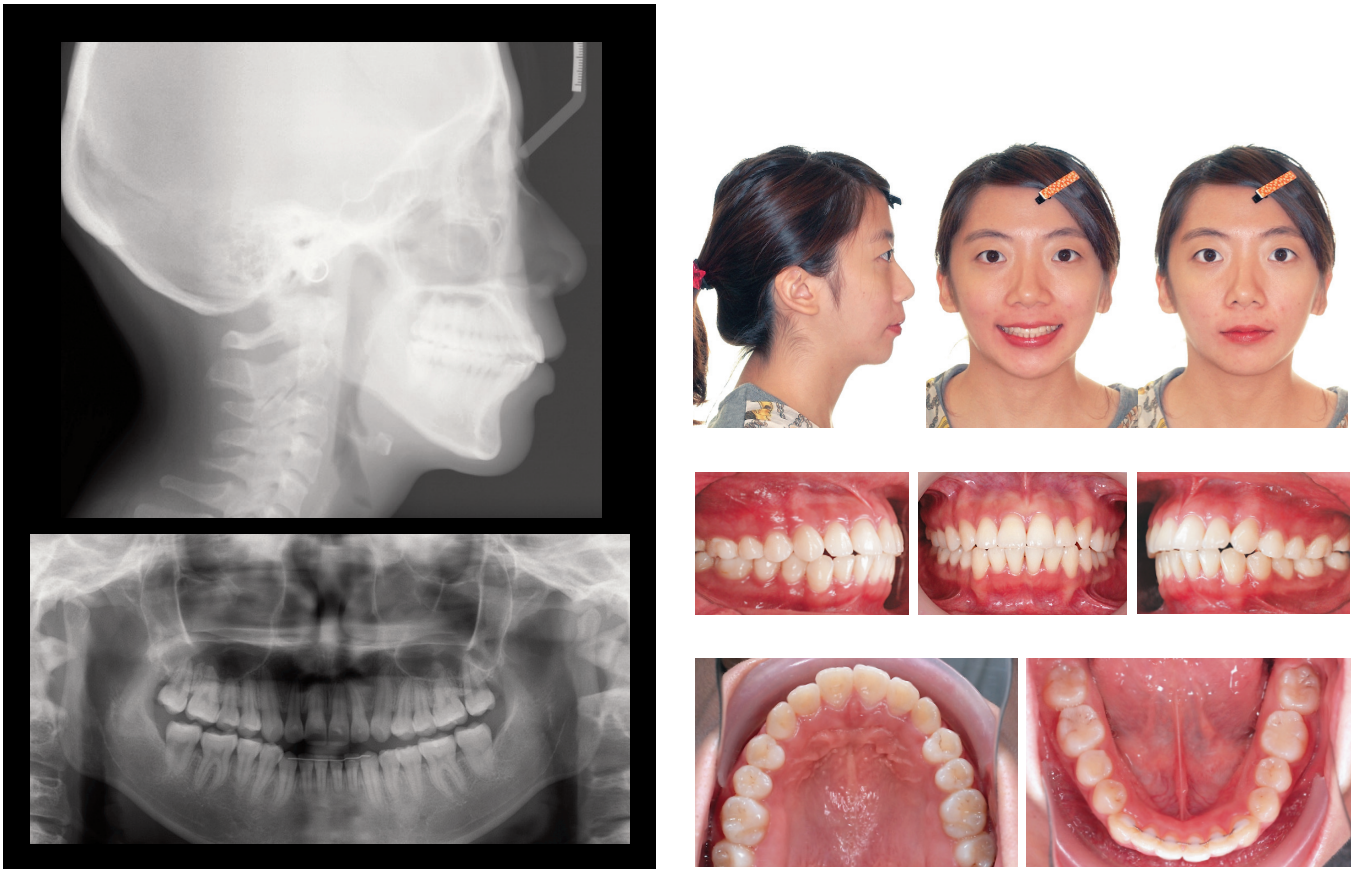


Fig. 21:
Three years after treatment a full set of records was obtained. Note the excellent facial esthetics and the stability of the nonextraction correction of a severe crowded malocclusion (DI 41) in a skeletally mature female. Note that the CRE score improved to 20 points compared to 28 points as scored immediately after treatment (Figs. 5 and 6).

(*RAP*). To take advantage of the RAP, midline correction elastics were applied immediately after the extractions according to the following pattern: Elastics (*Bear 1/4" 4.5oz*) from the upper right canine (*#6*) to lower left canine (*#22*), and from the upper left canine (*#11*) to the lower left 1st molar (*Fig. 17*).

In the 18th month of the treatment, distal tipping of the upper left second molar was noted. That problem was corrected by repositioning the bracket, so that a straight archwire produces a root distal moment on the second molar. It is important to correct angulation problems as early in treatment as possible, because they may affect sagittal relationships of the dentition.

Based on the cephalometric studies of Schudy,[14] there was concern that distal movement of both arches may open the bite by retracting molars "*into the wedge.*" Intrusive forces were applied in all four quadrants to control this potential problem.

A pleasing alignment was achieved after 20 months of treatment (*CRE 28*). Three years later the dentofacial result was stable and both the lip balance and protrusion were improved (*Figs. 21-23*). The CRE score decreased to 20 points (*Fig. 21*) as the occlusion settled post-treatment.

An unanticipated, growth-like post-treatment change was the 2-3 mm increase in mandibular

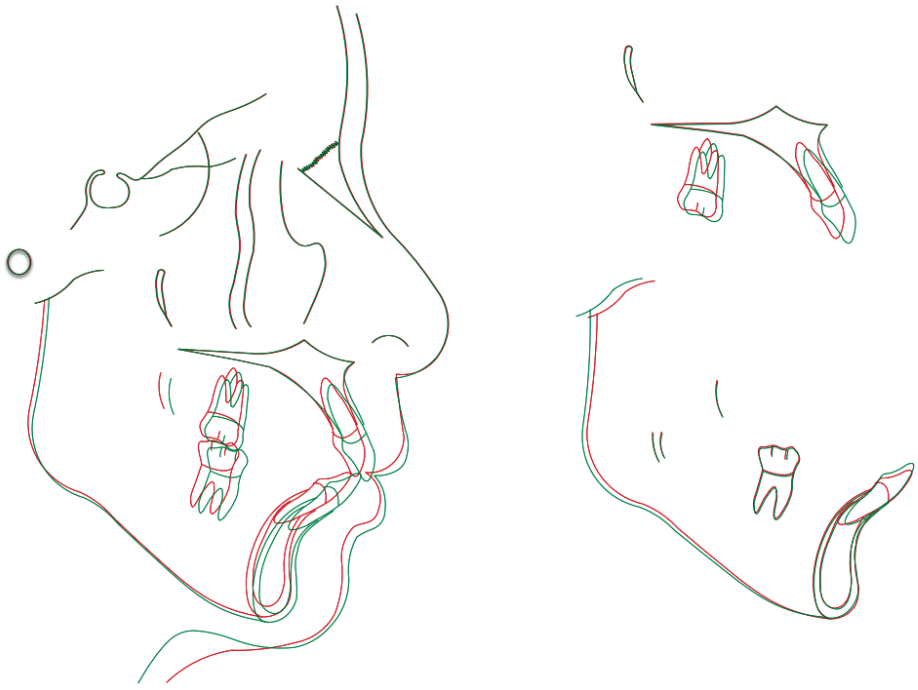


Fig. 22:
Superimposed tracings of the post-treatment (red) and the 3-year follow up (green) cephalometric radiographs show the dental and skeletal changes during treatment.

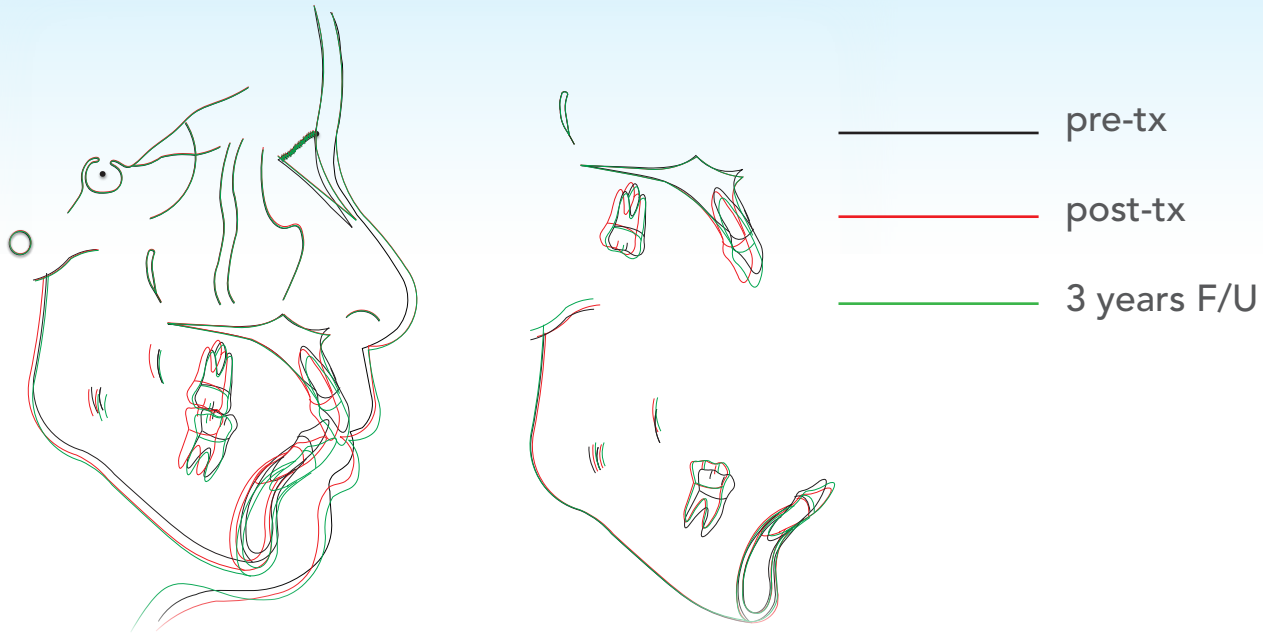


Fig. 23:
Superimposed tracings of the pre-treatment (black), the post-treatment (red) and 3-year follow up (green) cephalometric radiographs show the dental and skeletal changes during treatment.

length (*Fig. 22*), that was expressed as a downward and forward skeletal adaptation of the mandible. This does not appear to be "*growth*" in the usual sense, because the patient is a 20yr female, when the 3 year follow-up records were collected (*Fig. 22*), who failed to grow during the 20 months of active treatment from 15y5m to 17y01m (*Fig. 9*). The post-treatment skeletal change (*Fig. 23*) appears to be a favorable skeletal adaptation, consistent with the corrected malocclusion. Both Behrents[15] and Pancherz et al.[16] have noted late adult skeletal facial growth in both orthodontically treated[15] and untreated adults.[16] It seems likely that many (*if not all*) adults with a favorable dentofacial morphology can continue to experience anabolic skeletal modeling over a lifetime. This is an added incentive for orthodontists to achieve a good functional correction, particularly with regard to tongue posture and lip competence (*Fig. 19*).

Conclusion

When an adult or nongrowing adolescent patient declines extractions for treatment of severe crowding, the orthodontic options are challenging. Retraction of buccal segments with E-A miniscrews is a viable approach for creating the necessary arch length, but care must be exercised to prevent distal tipping of molars and opening of the vertical dimension of occlusion. The present severe malocclusion (*DI 41*) was rapidly corrected (*20 months*) to a satifactory dental alignment and facial form, that continued to improve. Three years later, a favorable skeletal and soft tissue adaptation

substanially improved facial esthetics. The results are consistent with a lifelong ability of humans to adapt to functional biomechanics.

Acknowledgment

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 41

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 = 3

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 2 pts.
Full Class II or III	=	4 pts. per side ____ pts.
Beyond Class II or III	=	1 pt. per mm. additional ____ pts.

Total = 2

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 2

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° 6 x 2 pts. = 12

≤ 26° = 1 pt.

Each degree < 26° ____ x 1 pt. = ____

1 to MP ≥ 99° = 1 pt.

Each degree > 99° 3 x 1 pt. = 3

Total = 23

OTHER (See Instructions)

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

Identify: Ectopic eruption UL canine

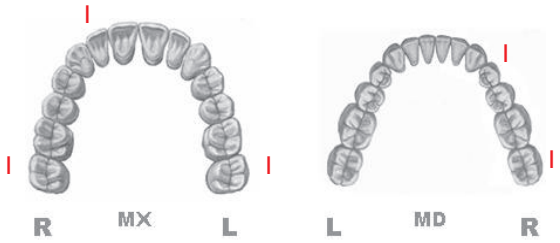
Total = 2

Cast-Radiograph Evaluation

Total CRE Score 28

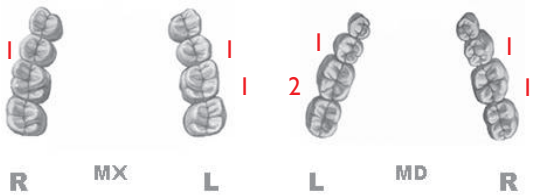
Alignment/Rotations

5



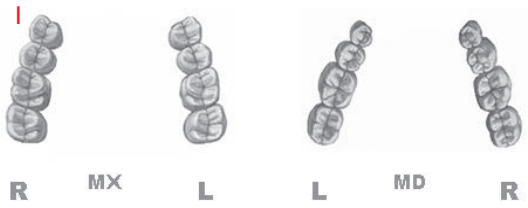
Marginal Ridges

8



Buccolingual Inclination

1

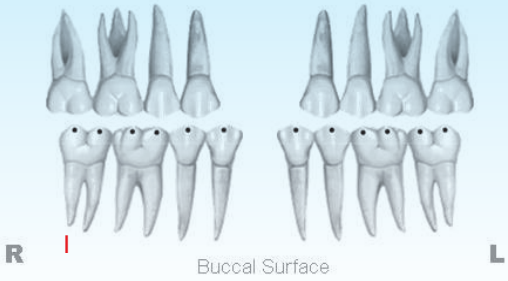


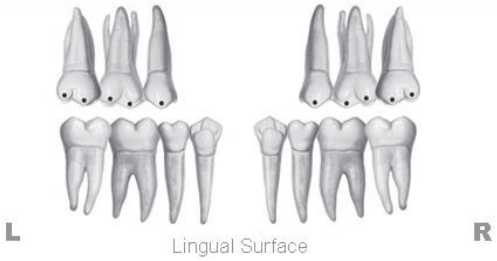
Overjet

5

Occlusal Contacts

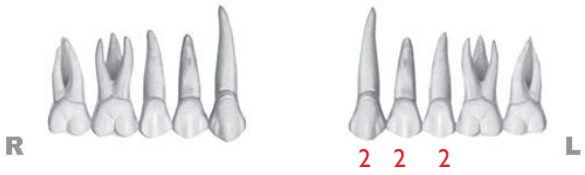
1





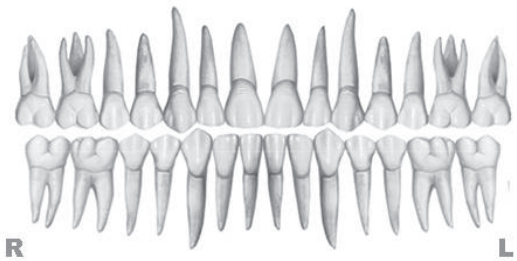
Occlusal Relationships

6



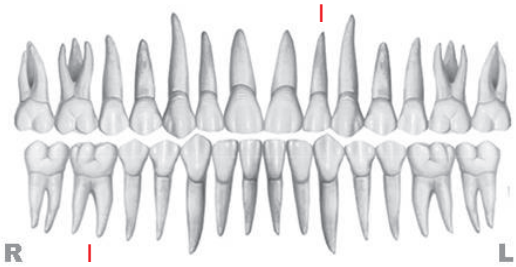
Interproximal Contacts

0



Root Angulation

2



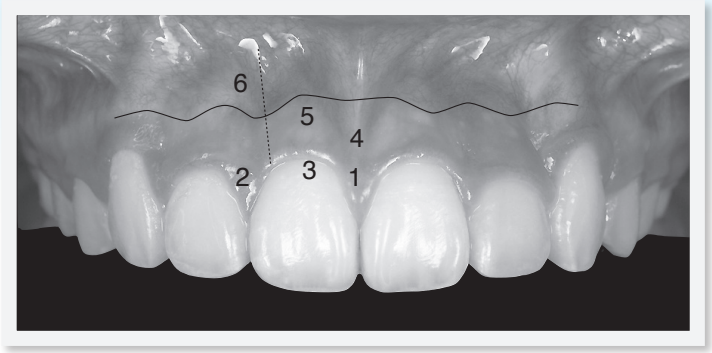
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 6

1. Pink Esthetic Score

Total = 2

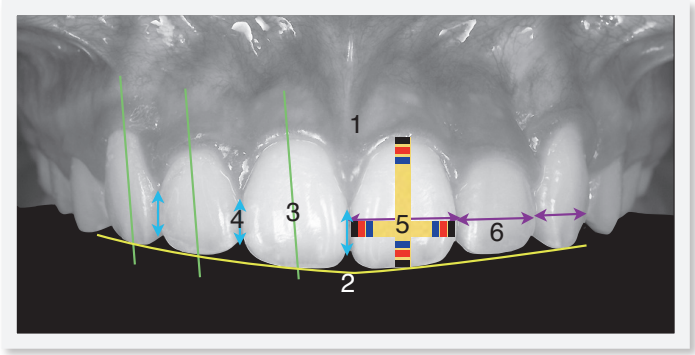


1. M & D Papilla	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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

2. White Esthetic Score (for Micro-esthetics)

Total = 4



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

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