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Drs. Eugene Roberts (right) and Chris Chang (center) receiving the CDABO Case Report of the Year Award from Dr. Rolf G. Behrents (Editor-in-Chief, AJODO) (left) in the 2019 AAO meeting.

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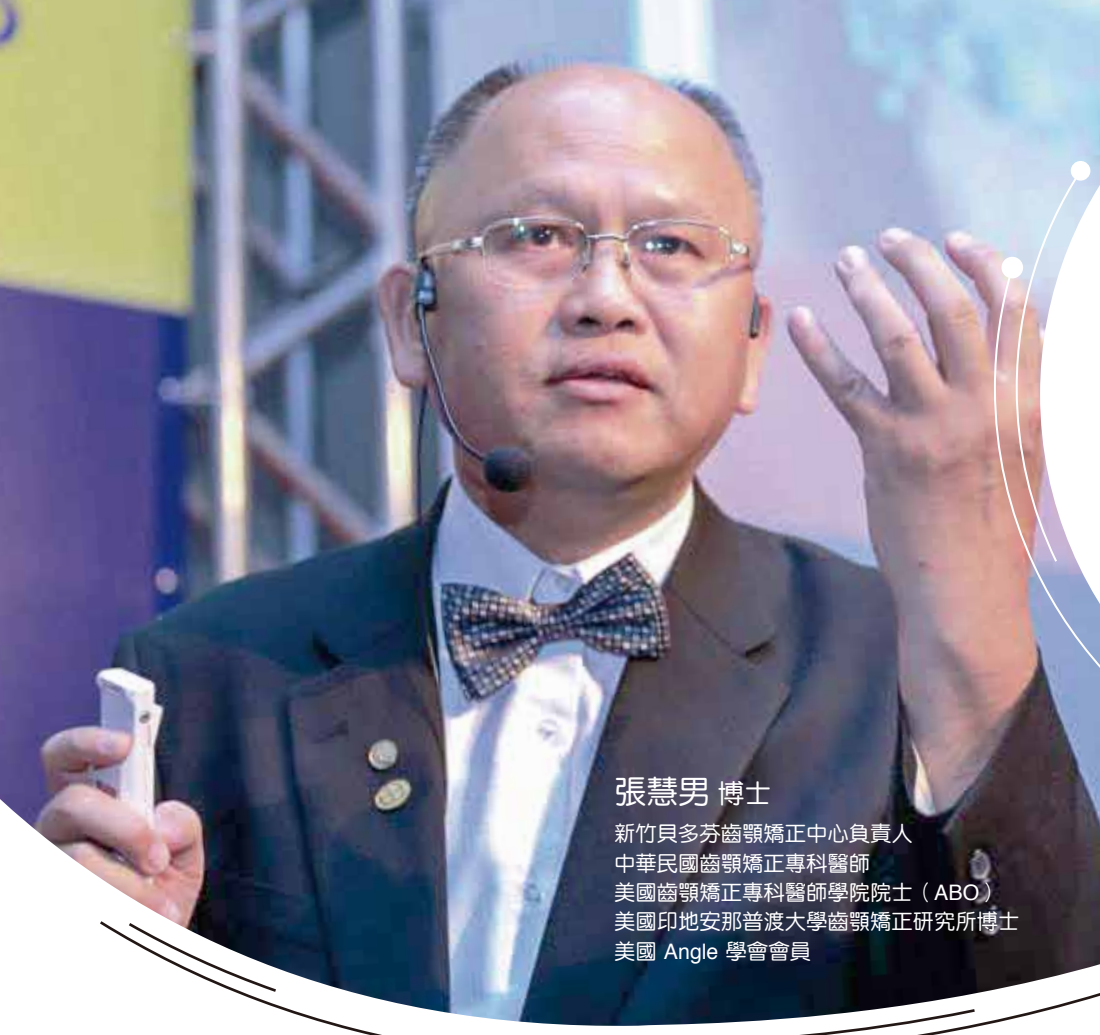

2019-20
熱愛學矯正

全新的貝多芬高效 Damon 矯正大師系列課程是由國際知名講師張慧男醫師親自規劃及授課，課程特色強調由臨床病例帶動診斷、分析、治療計畫擬定與執行技巧。此外，透過數位影片反覆觀看，課堂助教協助操作，以及診間臨床見習，讓學員在短時間能快速上手，感染「熱愛矯正學，熱愛學矯正」的熱情。

張慧男 博士

新竹貝多芬齒顎矯正中心負責人
中華民國齒顎矯正專科醫師
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美國 Angle 學會會員

Damon Master

(Thu) 9:00-5:00 中文授課

The Beethoven Damon Master Program, created by Dr. Chris Chang, is a two-year clinical program. Its hands-on orientation features case study-based diagnosis, analysis, treatment planning andresult evaluation. Combining in-class teaching assistants, after-class video review and chair-side observation, participants will learn to master the essential tips of the Damon System.

Year 1 2019

Module 1 - **4/25**/19' Module 4 - **7/18**
Module 2 - **5/16** Module 5 - **8/22**
Module 3 - **6/20** Module 6 - **6/28-29**（擇一）

Year 2 2019-20

Module 1 - **9/12** Module 4 - **12/12**
Module 2 - **10/3** Module 5 - **1/9**/20'
Module 3 - **11/21**

Damon + .014 Cu NiTi

Excellent Finishing

(Tue) 9:00-12:00 中文授課

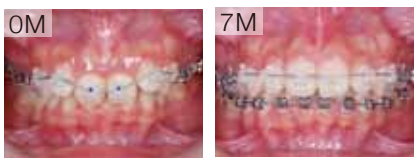
Critically reviewing classical literature and contemporary papers and applying lessons learned to clinical work; utilising ABO's DI and CRE standards to turning excellent finishing into attainable goals.

Finishing X

Module 9 - **5/14** Module 11 - **7/23**
Module 10 - **6/25**

Finishing XI

Module 1 - **8/27** Module 6 - **1/14**/20'
Module 2 - **9/10** Module 7 - **2/25**
Module 3 - **10/22** Module 8 - **3/24**
Module 4 - **11/12** Module 9 - **4/14**
Module 5 - **12/10** Module 10 - **5/19**
Module 11 - **6/16**



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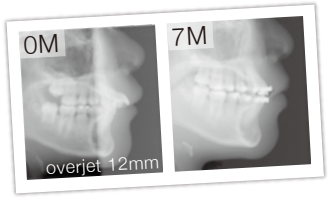
2019

Class 1 - **5/21-24** Class 2 - **12/03-06**

2020

Class 1 - **5/12-15** Class 2 - **12/08-11**



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A Single Journey Can Change the Course of a Life

It was a great honor to have been invited to speak on the world's most important orthodontic academic stage for the fourth consecutive year, the AAO annual meeting, from which I have just returned. My lecture not only drew a full house, but furthermore the overflow room was packed with many having to sit on the floor. Such moments make all the hard work of the Beethoven group seem worthwhile and I hope they will provide all Taiwanese Orthodontists with the incentive and motivation to continue the great progress which Taiwan has made on the international stage.

I am personally honored, but at the same time humbled by such warm receptions and that after my presentation there was over 40 minutes of photo requests and kind feedback from numerous attendees, further accentuating how Taiwan is becoming more and more prominent on the international Orthodontic circuit. My dear friend, Sandra Driver commented that she has never seen this kind of response in her 41 year professional orthodontic career.

Being invited to speak at such prestigious academic events means my team and I have to continually improve our clinical results and research innovation in order to partake in the most current discussions. Additionally, such events highlight Taiwan's cutting edge contributions, which allow our clinical visions to be further shared and spread around the world benefitting more patients on a global scale.

Chris Chang PhD, ABO Certified, Publisher of JDO

Mandibular Incisor Extraction and Interproximal Reduction Facilitates Clear Aligner Treatment to Correct UR2 Crossbite with Moderate Crowding

Abstract

***Introduction**: A 25 yr 6 mo male presented with a chief complaint of poor dental esthetics.*

***Diagnosis**: Facial assessment revealed reduced facial convexity (6˚) with a protrusive maxilla (SNA 84˚) and mandible (82˚). All other facial and skeletal measurements were within normal limits (WNL). The Class I malocclusion had an anterior crossbite (UR2), upper dental midline deviated 3 mm to the right, and 6 mm of crowding in the lower anterior dentition. The Discrepancy Index (DI) was 13.*

***Etiology**: The severe anterior crowding indicated limited development of arch width probably due to inadequate functional loading during the juvenile years. The UR2 crossbite is consistent with ectopic eruption.*

***Treatment**: Clincheck® software and clear aligners (Align Technology Inc., San Jose, CA) were used for treatment planning and correction of the moderate crowding and UR2 crossbite. The lower left central incisor (LL1) was extracted. The virtual set-up of the final alignment documented the need for extensive interproximal reduction (IPR) and maxillary arch expansion. Vertical rectangular attachments were bonded on lower incisors adjacent to the extraction site to close space and align roots. Simultaneous aligner-mediated tooth movement, IPR, and interproximal elastics were used to achieve a pleasing interproximal alignment. During active treatment, the aligners went off-track on UR2, so additional IPR was performed and auxiliaries were added for additional retention. After treatment with the 1st set of aligners was complete, the dental alignment was inadequate so the dentition was scanned and resubmitted to prepare a new set of finishing aligners to achieve expansion of the upper arch, torque correction, angulation control, and detailing.*

***Results**: All the teeth were moved the minimum distance to achieve an optimal result according to the virtual treatment plan, designed in the Clincheck® software. This moderate malocclusion with a DI of 13, was treated in 24 months to an excellent outcome: Cast-Radiography Evaluation (CRE) score of 6, and Pink & White dental esthetic score of 4. Both arches were well-aligned in a Class I relationship with the lower midline centered on the middle incisor (LR1). Small black triangles in the lower anterior region required restoration rather than IPR and space closure.*

***Conclusion**: Class I crowded malocclusion with anterior crossbite can be effectively treated with aligners, extraction of a lower incisor, and IPR. This method avoids braces, multiple extractions and miniscrews, but it did require extensive IPR. However, the outcome featured a comprised dental midline with lower anterior black triangles. (J Digital Orthod 2019;55:4-22)*

Key words:
Invisalign, clear aligner treatment, severe crowding, anterior crossbite, occlusal canting, mandibular incisor extraction, end-on Class III

History and Etiology

A 25 yr 6 mo male presented with chief complaint (*CC*) of poor dental esthetics. Clinical examination revealed a straight lateral profile, upward occlusal plane cant on the right side, lower midline deviation 3mm to the right, intermaxillary crowding, and an upper right lateral incisor (*UR2*) in crossbite. The patient requested aligner treatment rather than fixed appliances.

Dr. Yu-Hsin Huang,
Diplomate, International Association of Orthodontists and Implantologists (Left)

Dr. Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center)

Dr. W. Eugene Roberts,
Editor-in-chief, Journal of Digital Orthodontics (Right)

There was no contributing medical or dental history. The etiology was deemed insufficient intermaxillary loading to achieve adequate arch width, and ectopic eruption of the UR2. Developmental tipping of the maxillary incisors to the right resulted in the superior occlusal cant on the right side (*Figs. 1 and 2*). Pretreatment panoramic and cephalometric radiographs are shown in Figs. 3 and 4. The cephalometric measurements are presented in Table 1.

Fig. 1: Pre-treatment facial and intraoral photographs

Diagnosis

Facial:

- Facial Height: *Na-ANS-Gn was increased (54%) with a tapered facial form (Table 1)*
- Lip Protrusion: *Relatively retrusive lips (-2mm upper and -1mm lower) to the E-Line (Table 1)*
- Symmetry: *Upper dental midline 3mm to the right, canted occlusal plane to the right (Fig. 1)*
- Smile Line: *Upper lip curtain has an asymmetrical elevation on the right side consistent with the occlusal cant (3mm inferior on the patient's left side)*

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	84°	84°	0°
SNB° (80°)	82°	82°	0°
ANB° (2°)	2°	2°	0°
SN-MP° (32°)	31°	31°	0°
FMA° (25°)	23°	23°	0°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	4 mm	3 mm	1 mm
U1 To SN° (104°)	108.5°	105.5°	3°
L1 To NB mm (4 mm)	5 mm	4 mm	1 mm
L1 To MP° (90°)	88°	84°	4°
FACIAL ANALYSIS			
E-LINE UL (-1 mm)	-2 mm	-5 mm	3 mm
E-LINE LL (0 mm)	-1 mm	-2 mm	1 mm
%FH: Na-ANS-Gn (53%)	54%	54%	0%
Convexity: G-Sn-Pg' (13°)	5°	4.5°	0.5°

Table 1: Cephalometric summary

Skeletal:

- Intermaxillary Relationship: *Protrusive maxilla (SNA 84°) and mandible (SNB 82°) (Table 1)*
- Mandibular Plane: *Decreased (SN-MP 31°, FMA 23°) (Fig. 4) (Table 1)*
- Vertical Dimension of Occlusion (*VDO*): *Excessive Na-ANS-Gn (59%) (Table 1)*
- Symmetry: *Within normal limits (Figs. 3 and 4)*

Dental:

- Classification: *Class I bilaterally*
- Overbite: *3mm*
- Overjet: *2mm*
- Missing/Unerupted Teeth: *None*
- Symmetry: *Upper midline deviated 3mm right with an occlusal cant (Figs. 1 and 5)*

The ABO Discrepancy Index (*DI*) was 13 as documented in to the subsequent worksheet.[1]

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

Fig. 3: Pre-treatment panoramic radiograph

Fig. 4: Pre-treatment cephalometric radiograph

Specific Objectives of Treatment

The treatment objectives were to correct: 1. UR2 crossbite, 2. asymmetrical maxillary arch, 3. canted occlusal plane, 4. crowded dentition, and 5. upper dental midline to the facial midline.

Maxilla (all three planes)**:**

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

Mandible (all three planes)**:**

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

Maxillary Dentition:

- A - P: *Slightly retract incisors*
- Vertical: *Slightly intrude incisors*
- Inter-molar / Inter-canine Width: *Maintain/ Expand*

Fig. 5:
Left: A frontal intraoral photographs show the occlusal cant and the label position of the LL1. Right: The lingual view of the virtual set-up after extraction of the LL1 shows the deepbite and mesially tipped lower incisors adjacent to the extraction site.

Mandibular Dentition:

- A - P: *Retract incisors*
- Vertical: *Extrude incisors*
- Inter-molar / Inter-canine Width: *Maintain*

Facial Esthetics:

- Retract the upper lip

Treatment Alternatives

The extraction decision chart proposed by Dr. Chris Chang[1] was reviewed. The recommendation was that a malocclusion with moderately crowded dentition, single tooth crossbite, and an occlusal relationship of or near Class I, is not optimally treated with extractions.[2] However, the facial profile, mandibular plane angle, overbite and incisor inclination are important co-factors in the treatment planning process. As illustrated in Fig. 6, three options were proposed:[3,4]

1. **Option 1**: Relieve the crowding with arch expansion, proclination of incisors, and interproximal reduction (*IPR*).
2. **Option 2**: Extract 4 bicuspids to relieve the crowding and close the residual space.
3. **Option 3**: Extract the LL1 and use IPR to provide space for intermaxillary alignment.

Rationale: When treating a patient with aligners, assessment of overall tooth movement is very important for determining the final outcome. Translating teeth long distances requires more time, anchorage and patient compliance. Off-tracking can occur when teeth are markedly displaced, aligners are changed too frequently, and/or patient cooperation is inadequate. Option 1 is non-extraction treatment that maintains the entire dentition, and corrects the midlines. However, extensive IPR is required to avoid excessive flaring of the incisors, and thin enamel may compromise small teeth like lower incisors. In addition, up to four mini-

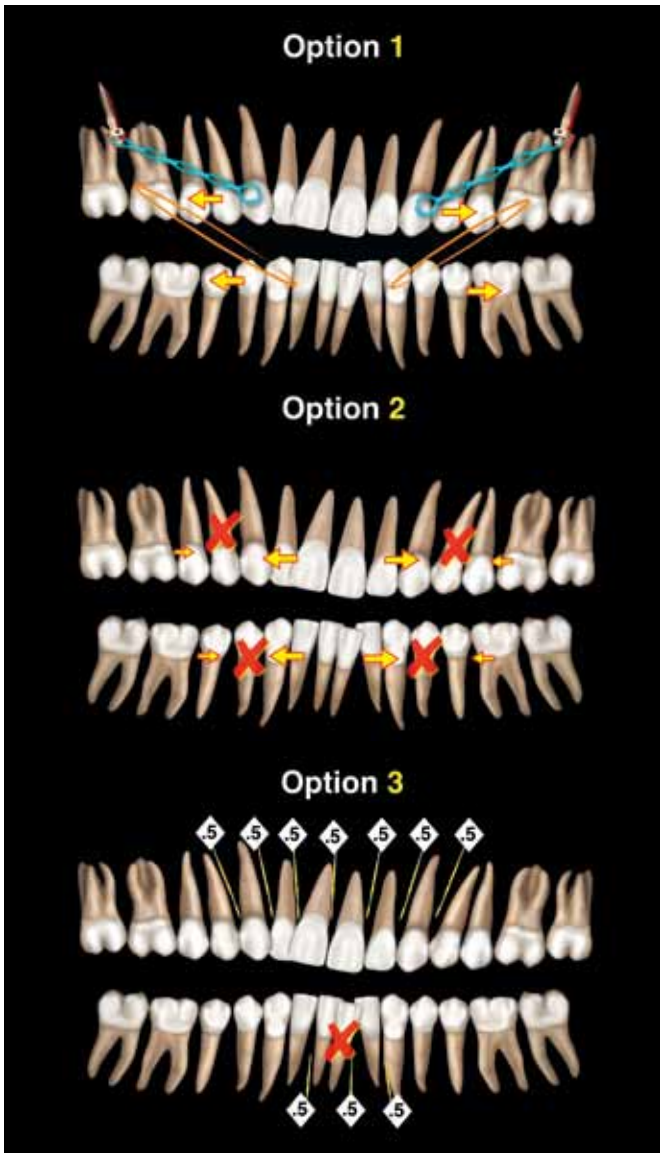

Fig. 6: Diagrams of the three treatment options. See text for details.

screws may be needed to supplement posterior anchorage. Option 2 utilizes 4-bicuspid-extraction to provide space for correcting crowding. However, the width of four premolars is much greater than the space needed. Closure of the residual space would decrease lip protrusion and compromise facial esthetics. Option 3 is a compromise proposing extraction of only the labially displaced incisor (*LL1*). Aligners with tooth attachments will close space and aline the roots of lower incisors. The circumference of the upper anterior dentition is reduced with IPR. The latter option (*3*) requires the least amount of tooth movement and arch expansion. The patient selected Option 3 because it was the most conservative approach and would probably require fewer aligners to achieve a predictable and stable outcome.

Treatment Progress

A dedicated treatment planning system (*Invisalign® by Align Technology, Inc, San Jose, CA, USA*) was used to plan the treatment (*Fig. 7*). In the initial alignment phase, long rectangular attachments were used for the UR2 facial movement, as well as to close the lower extraction space. Fig. 8 is a series of intraoral photographs documenting the initial 18 mo of progress. Optimized attachments were used for the correction of rotation, intrusion, and extrusion. Horizontal attachments were used to help maintain the torque and angulation while the dental arch was being expanded and the Curve of Spee was leveled. IPR was performed before the start of the aligner treatment. Simultaneous movement and IPR were programmed for the initial treatment sequence. The interval for changing aligners was every 10 days. After 3 months of active treatment, there was a gap between the UR3 and the aligner (*off-track*). The patient's compliance was evaluated and reinforced, in addition to increasing the interval between aligners to 14 days. One month later, a resin button and short elastics (*Chipmunk 1/8-in, 3.5-oz*) were applied to optimize the fit between the UR3 and aligners (*Fig. 9*).

After 8 months of treatment, the LL5 showed incomplete rotation, and lower incisors adjacent to the extraction site were tipped together (*Fig. 10*). The attachment on the LL5 was removed to prevent intrusion. The tipping and interproximal gap

Fig. 7: The initial setup with the prescribed attachments shows the interproximal areas requiring IPR and the amount required.

between LL2 and LR1 was evaluated. The dentition was scanned and additional aligners were constructed. In the upper arch, the right incisors and canine were off-track during the arch expansion and UR2 crossbite correction (*Fig. 11*). Off-tracking was corrected by performing more IPR than was originally planned. Additional buttons and short elastics (*Chipmunk 1/8-in, 3.5-oz*) were used to extrude the affected teeth to correct the off-tracking (*Figs. 12 and 13*).

After completion of treatment with the first set of aligners, an iTero Element® intraoral scan (*Align Tech, Inc, San Jose, CA, USA*) was performed to provide a current 3D dataset to design the detailing aligners.[5] The

Fig. 8:
The first 18 mo of progress is shown in a progressive series of frontal (upper) and right buccal intraoral photographs (lower). See text for details.

Fig. 9: Steps are shown with multiple pliers for creating notches in the aligners to accommodate intermaxillary and/or vertical elastics.

Fig. 10:
Checking the activation of an aligner is facilitated by drawing a black line around each attachment. See text for details.

Fig. 11:
Off-tracking is evidenced by gaps between the aligner and the incisal edges of the UR3, UR2, and UR1. See text for details.

Fig. 12: One of the steps for correcting off-tracking is additional IPR. See text for details.

Fig. 13: A series of intraoral photographs document progress 10 mo into treatment.

final correction focused on the inclinations for UR3, UR2, UR1, UL1, LL2, and LR1. The LL5 rotation was corrected with the optimized attachments. Up and down elastics were applied for seating the posterior occlusion.[6] When the problems had been resolved and teeth were aligned in the proper position, an upper frenectomy and gingivoplasty were performed using a diode laser (*Fig. 14*). After 24 months of treatment, all attachments and auxiliaries were removed and operative dentistry procedures were performed for LL2 and LR1.

Results Achieved

This moderate malocclusion (*DI 17*) was corrected to a relatively symmetric result with a near ideal Class I outcome (*CRE 6*) with 24 months of clear aligner treatment as documented in worksheet 2 at the end of this report. One lower incisor (*LL1*) was extracted and extensive IPR was performed as needed. The cephalometric analysis (*Table 1*) shows a slightly decreased facial profile (*0.5°*), but no skeletal changes. The incisors were slightly retracted (*~1mm*) and uprighted (*3-4°*) which resulted in decreased lip protrusion (*lower 1mm, upper 3mm*). Overall the facial changes were modest and the patient was pleased with the dental esthetics (*Figs. 15-17*). As shown (*Figs. 18 and 19*) and tabulated (*Table 1*), the specific achievements were:

Fig. 14:
A selective gingivectomy and frenectomy are performed to improve esthetics. See text for details.

Maxilla (all three planes)**:**

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

Mandible (all three planes)**:**

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

Maxillary Dentition

- A - P: *Slightly retracted incisors*
- Vertical: *Slightly intruded incisors*
- Inter-molar / Inter-canine Width: *Maintained / Increased*

Mandibular Dentition

- A - P: *Incisors were retracted.*
- Vertical: *Slight extrusion of lower incisors*
- Inter-molar / Inter-canine Width: *Maintained*

Facial Esthetics:

- Protrusive maxillary lip was corrected (*Fig. 15*)

Fig. 15: Post-treatment facial and intraoral photographs

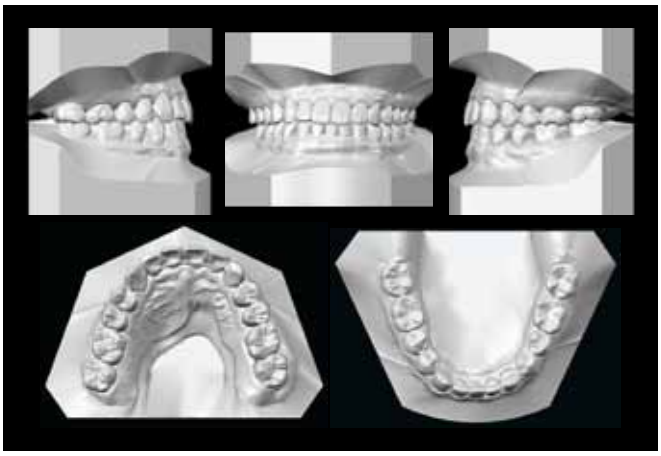

Fig. 16: Post-treatment dental model (casts)

Fig. 17: Post-treatment panoramic radiograph

Fig. 18: Post-treatment cephalometric radiograph

Retention

To maintain the width of both arches, fixed retainers were placed on all maxillary incisors and from canine to canine in the lower arch. Two ESSIX® (*Dentsply Sirona, Harrisburg PA*) overlay retainers were provided to retain the leveling and alignment of the dentition. The patient was instructed to use the removable retainers full time for the first month and then only while sleeping.

Final Evaluation of Treatment

A Class I occlusion with ideal overbite and overjet was achieved. The maxillary midline was in the center of the three lower incisors. The ABO Cast-Radiography Evaluation (*CRE*) was 6 points. The only deficiencies were occlusal contacts (*4 points*) and

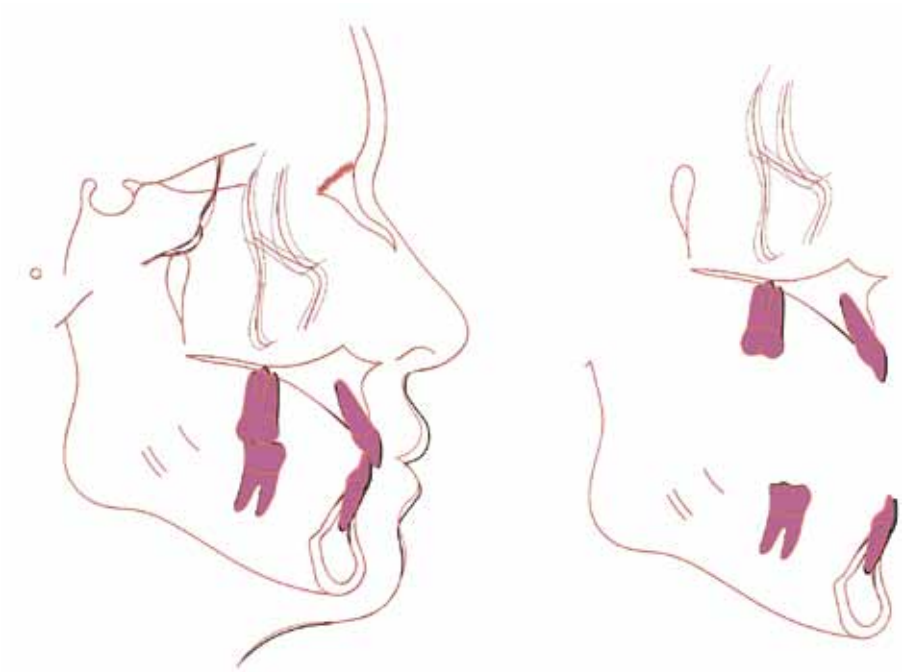

Fig. 19:
Cephalometric tracings before (black) and after (red) treatment document the dentofacial changes associated with aligner treatment. Superimposition are cranial base (left), maxilla (upper right), and mandible (lower right).

marginal ridge alignment (*2 points*) (*Figs. 17 and 18*). The pink and white dental esthetic score was 3. See Worksheet 3 at the end of this report.[7]

Discussion

Since the patient was symmetric in the buccal segments (*Class I*), and increased lip protrusion was undesirable, the major diagnostic decision was which tooth or teeth to extract. Extracting a premolar in each segment is a common approach for managing Class I crowded malocclusion. However, the arch length for four premolars approaches 30mm and the crowding was <6mm in each arch. Closing the space would retract the incisors and flatten the lips. The alternate option was to extract a lower incisor and close the space, but that approach creates excessive arch length in the upper anterior segment. The latter is best managed with IPR in the maxillary anterior and/or restorative build-up of one or more of the lower incisors. Before extracting any teeth it is wise to simulate the result to decide if the outcome is acceptable. Invisalign® treatment planning and Clincheck® software are ideal for this process.

Invisalign® clear aligners utilize three 'smart' innovations: SmartTrack®, SmartForce®, and SmartStage®. With a collective experience of 6 million patients globally, the software accurately predicts the tooth movement required to resolve a malocclusion. Clincheck® software produces a virtual plan that assesses and compensates for Bolton discrepancies, tooth movement parameters, changes in axial inclination, and the numbers of aligners required to optimally manage the malocclusion. This digital information is quantified and analyzed to choose the most efficient and predictable plan to achieve the desired outcome.[8,9] Other considerations were that the LL1 had an abraded incisal edge, and was labially displaced which may be a predisposition to gingival recession (*Fig. 5*).[10,11] Clincheck® alignment of the intact dentition showed that LL1 would be unesthetic in addition to having fragile labial gingiva. When the LL1 was removed the set-up of the dentition was more harmonious, but it was necessary to align the maxillary midline in the center of the middle lower incisor. Although aligned midlines is an important diagnostic consideration, it is not an important outcome criteria. It is not even a consideration in the ABO CRE score. Furthermore, an upper midline can deviate 2-4mm to the facial midline and still be acceptable outcome.[12,13] For the present patient, the ideal maxillary midline alignment was in the center the middle lower incisors, which is about a 3mm deviation from either interproximal surface of the 5.5mm LR2. The patient was shown the preposed outcomes for both LL1 or four premolar extraction,[14] and chose LL1 as the most conservative option.

When anterior crowding is corrected with orthodontic treatment in adults, interproximal areas often appear as back triangles due to the normal gingival recession of aging. These problems are usually managed with IPR and space closure to decrease or eliminate the black triangles. The IPR procedure is also advantageous for correcting crowding, as well as for controlling excessive canine expansion and/or axial inclination of the incisors.

A tooth movement response involves bone modeling along PDL and subperiosteal surfaces, as well as bone remodeling (*turnover*) within the supporting alveolar process.[15,16] Because of the limitation in the linear rate of osteoclastic resorption (*~40μm/day*), teeth move slower through dense bone, because there are fewer surfaces for removing bone to relieve necrotic areas of the PDL.[15] Tooth movement requires a continuous load of sufficient magnitude to displace the root within the PDL to create areas of compressed and widened PDL to induce bone resorption and formation, respectively. Aligners are a progressive series of appliances that "*nudge targeted teeth*" ~0.2 mm with each new aligner along a path of tooth movement. The load is renewed when each new aligner is introduced, usually at 10-14d intervals.

When orthodontic force is applied to a tooth, there is friction between the aligner and the crown of a tooth that facilitates tipping-type movements. If an applied moment is required such as to rotate or translate a tooth, the aligner must engage the tooth at two or more points to generate a couple, i.e. two parallel forces that are equal in magnitude, opposite in sense and do not share a line of action (*Wikipedia*). Attachments bonded on tooth surfaces are designed to provide the required moment to force ratio (*M:F*) to achieve the desired tooth movement in three dimensions (*3D*). If an iteration in the path of tooth movement that specifies a specific aligner is an excessive activation and/or the patient fails to adequately cooperate, the aligner can disengage from a tooth or teeth: "*off-tracking*." This is a lack of adequate aligner contact with the surface of a tooth or teeth. Off-tracking interrupts the specific force system designed to perpetuate the path of tooth movement. Furthermore, the unplanned fit of the aligner may cause undesirable tooth movement. Examining the fit, retention, and the patient's sense of pressure when the aligner is seated are critical clinical evaluations at each visit. If off-racking is detected, the patient is instructed to bite on cotton rolls in the areas where the aligner is visually separated from the teeth, and/or wear vertical elastics if indicated until the off-tracking is corrected. Once the fit of the problem aligner is maintained in a passive state, and there is no longer a sense of pressure when the aligner is seated, the patient can progress with subsequent aligners as planned.

Root movement to align the lower incisors adjacent to the extraction site is challenging with aligners. Long vertical rectangular attachments on both incisors are essential to generated an adequate couple on the labial surfaces.[17,18] Aligners to achieve root movement must deliver a load with a high M:F. Mesial force to hold the crowns together is combined with another pair of mesial forces at the gingival aspect of the attachments. A couple (*moment*) is generated to move both roots mesially (*together*) until the desired root positions (*paralleling*) are achieved. By applying a nontoxic black substance such as graphite from a pencil around the attachment, it is easier to visualized the proper activation as the aligner as it is seated (*Fig. 10*).

After the completion of treatment with the first set of aligners, upper arch expansion and labial movement of the UR2 were under-corrected (*Figs. 20 and 21*).

Fig. 20:
Images of the maxillary dentition show the original malocclusion with the planned attachments (upper), virtual outcome projection (middle), and actual outcome after the initial aligner series. See text for details.

Arch expansion is readily achieved if the buccal segments are tipped palatally prior to treatment (*Fig. 22*).[19,20] If maxillary buccal segments must be translated, the mechanics are more complex, require a higher M:F, and are less predictable. Actual clinical expansion with aligner treatment is usually less than the predicted (*virtual*) results produced by the Clincheck® software.[21] To achieve the desired correction it is necessary to submit new progress scans of the dentition and design an overcorrection of the deficiencies. Then a new set of aligners is constructed to complete the treatment.[21-23]

To decrease the risk of off-tracking, when resolving moderate crowding without an extraction space, it is essential to perspectively perform adequate IPR to create enough space to stage the correction of rotations and align the dentition. If IPR is inadequate to accomplish a given stage of treatment, off-tracking and a delay in treatment is probable. For substantial lower anterior crowding, particularly

Fig. 21:
Left: The actual outcome (blue) is superimposed on the projected result (white). Right: Irregularities are noted in the maxillary arch, especially near the UR2, that was originally in crossbite.

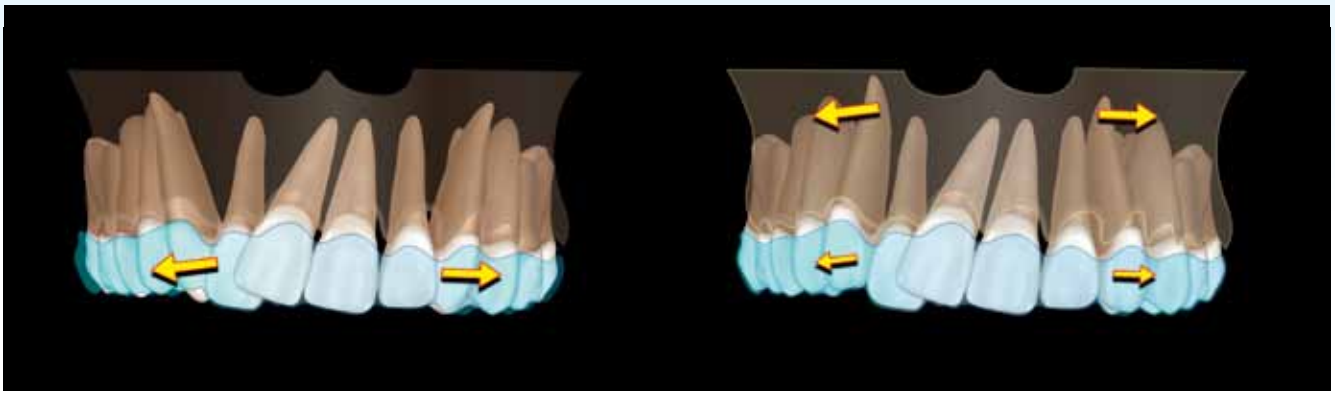

Fig. 22:
Left: Expansion of upper canines (arrows) is part of the original treatment plan. Right: To avoid excessive buccal tipping of the posterior segments, buccal root movement (upper arrows) is required in the maxillary poster segments. See text for details.

when an incisor is displaced labially or lingually, extraction is a highly predictable treatment option, which minimizes arch expansion and the distances teeth must be moved. However, alignment of the adjacent teeth may require extensive root movement (*Figs. 7 and 8*).

Leveling the Curve of Spee is similar to the deepbite resolution when using Invisalign G5®. The lower premolars are extruded with gingival bevel attachments, which also serve as anchorage to intrude the incisors. Optimized attachments for anchorage and bite ramps are also recommended when correcting a severe deep bite.[24-26]

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 13

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 = 2

Total = 2

OVERBITE

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

Total = 3

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 = 4

6 mm (lower)

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 = 0

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° 2° = 4 pts.

Each degree < -2° _____ x 1 pt. = _____

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

SN-MP 31°
≥ 38° = 2 pts.
Each degree > 38° _____ x 2 pts. = _____

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

1 to MP ≥ 99° 88° = 1 pt.
Each degree > 99° _____ x 1 pt. = _____

Total = 0

OTHER (See Instructions)

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

Identify: Occlusal canting

Total = 4

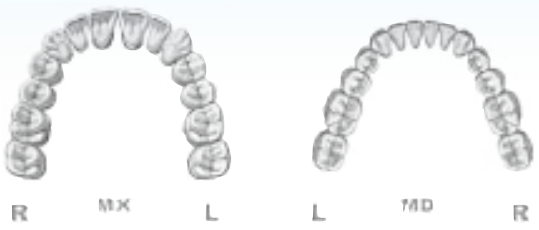
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 6

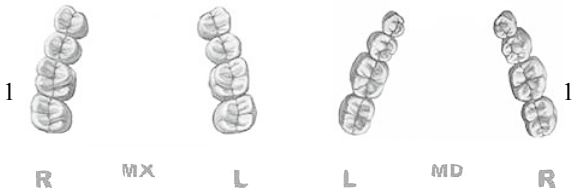
Alignment/Rotations

0



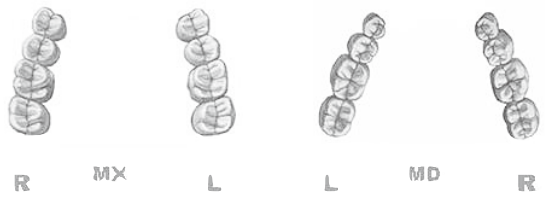
Marginal Ridges

2



Buccolingual Inclination

0

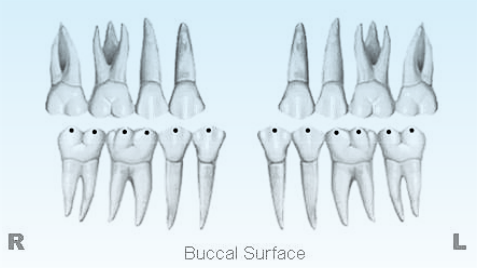


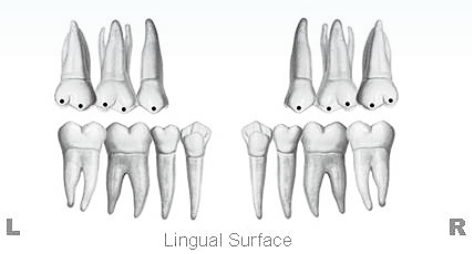
Overjet

0

Occlusal Contacts

0



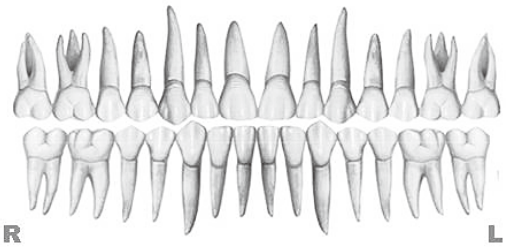


Occlusal Relationships

4

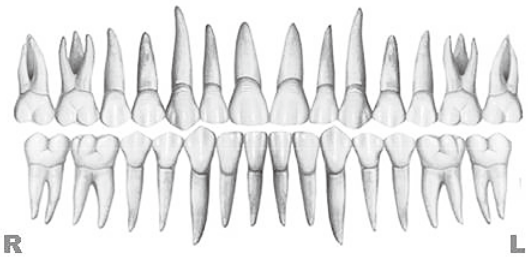
Interproximal Contacts

0



Root Angulation

0



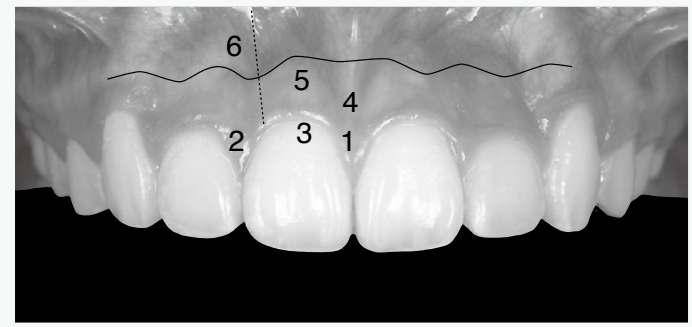
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 3

1. Pink Esthetic Score

Total = 1

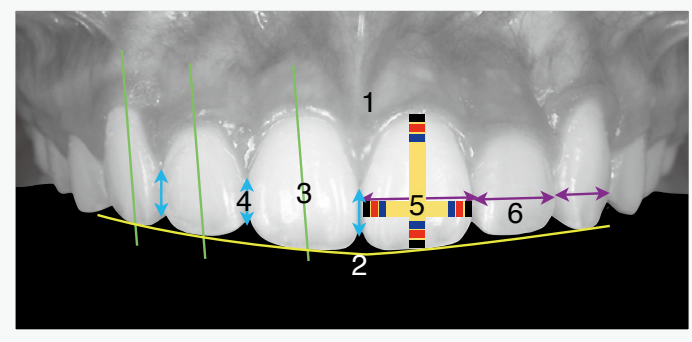


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

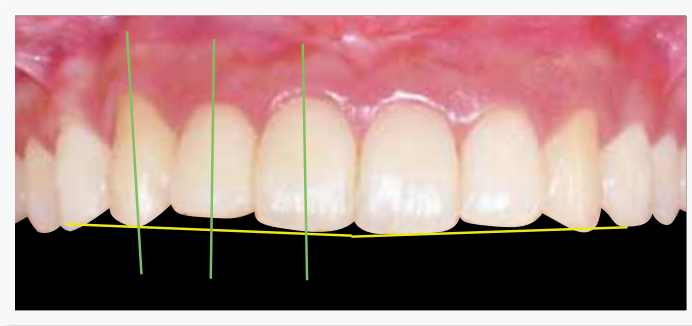
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	(0)	1	2
4. Level of Gingival Margin	0	(1)	2
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 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



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

賀

貝多芬矯正團隊

榮獲2019
美國最優矯正病歷獎

首次華人獲此殊榮
2019 Case Report of the Year **Award**

精彩影片連結

https://goo.gl/Dnu94Z

Shuang-An Lee

Chris H. Chang

W. Eugene Roberts

AJO-DO
American Journal of Orthodontics & Dentofacial Orthopedics

January 28, 2019

Shuang-An Lee
Chris C.H. Chang
W. Eugene Roberts

RE: CDABO Case Report of the Year Award

Dear Drs. Lee, Chang, and Roberts:

It is with great pleasure that I write to inform you that your article, "Severe unilateral scissors-bite with a constricted mandibular arch: Bite turbos and extra-alveolar bone screws in the infrazygomatic crests and mandibular buccal shelf," has been selected to receive the 2019 CDABO Case Report of the Year Award. Congratulations.

The College of Diplomates of the American Board of Orthodontics (CDABO) is composed of orthodontic clinicians who have passed all phases of the American Board of Orthodontics examination. The award was established by the College to recognize excellence in clinical orthodontics. It is given annually to the authors of the best Case Report published during the previous year in the *American Journal of Orthodontics and Dentofacial Orthopedics*.

The CDABO award will be presented at the annual meeting of the *AJO-DO* editorial board, which is held in conjunction with the AAO Annual Session. This year, the editorial board will meet Sunday, May 5, from 7:00 to 9:00 am, in Los Angeles, Calif. You and your co-authors are invited to join the board for this breakfast meeting and be recognized by the Journal's editors and associates.

I hope that you plan to attend the AAO Annual Session in Los Angeles and can receive your certificate and recognition in person. Please let me know if you will be able to attend the AJO-DO Editorial Board Meeting on Sunday, May 5.

Again, I offer my congratulations for receiving this prestigious award.

Sincerely,

Rolf G. Behrents, DDS, MS, PhD
Editor-in-Chief, AJO-DO

CASE REPORT

AJO-DO

Severe unilateral scissors-bite with a constricted mandibular arch: Bite turbos and extra-alveolar bone screws in the infrazygomatic crests and mandibular buccal shelf

Shuang-An Lee,[a] Chris C. H. Chang,[b] and W. Eugene Roberts[c]
HsinChu City, Taiwan, Indianapolis, Ind, and Loma Linda, Calif

A 33-year-old woman had a chief complaint of difficulty chewing, caused by a constricted mandibular a
and a unilateral full buccal crossbite (scissors-bite or Brodie bite). She requested minimally invasive tre
ment but agreed to anchorage with extra-alveolar temporary anchorage devices as needed. Her facial for
was convex with protrusive but competent lips. Skeletally, the maxilla was protrusive (SNA, 86°) with
ANB angle of 5°. Amounts of crowding were 5 mm in th

anterior flaring of the incisors. The scissors-bite and lingu
were sufficiently corrected after 3 months of treatment to
the right posterior segments to intrude the maxillary right
for extrusion of the posterior teeth to level the mandibular
anchored the retraction of the maxillary arch. In 27 months, this difficult malocclusion, with a Discrepan
Index score of 25, was treated to a Cast-Radiograph Evaluation score of 22 and a pink and white esthe

AJO-DO, Volume 154, Issue 4, Pages 554–569

Dental Clinic Established 1996
Beethoven

International Workshop

Digital Orthodontics, OBS, VISTA

		Digital Orthodontics, OBS, VISTA	Keynote optional
2020	Session A	05/12–14	05/15
	Session B	12/08–10	12/11

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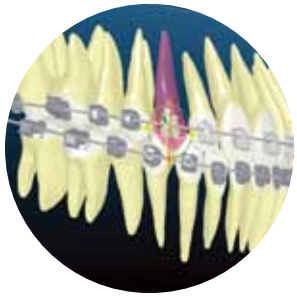
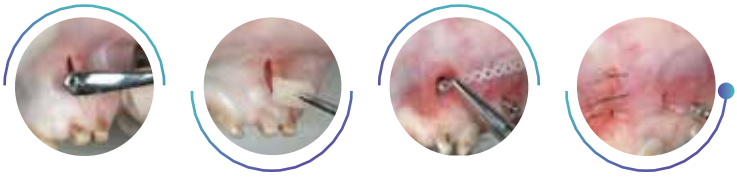


INSIGNIA

OBS

Beethoven's International Workshop is designed for doctors who provide orthodontic treatment using the Damon and Insignia System. This workshop is consisted of lectures, hands-on workshops as well as chair-side observation sessions. Participants will have the opportunity to observe clinical treatment, didactic lectures, live demonstration and gain hands-on practice experiences involving TAD placement, indirect bonding, CBCT-enhanced digital treatment planning for Insignia.



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Day 123	USD	3,600	Early bird rate: $100 off (advanced registration two months prior to the course date)
Day 4	USD	600	Early bird rate: $100 off (advanced registration two months prior to the course date)

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Course Schedule

Day 1 **Chair–side observation**

Day 2 **Insignia Lecture, Chair–side observation**

Chris' Lecture:
Digital Orthodontics with TAD

Day 3 **VISTA Lecture & workshop**

Chris' Lecture:
VISTA for Impacted Cuspids

* The topics for VISTA workshop:

1. VISTA with Screw Placement
2. VISTA with Connective Tissue Graft
3. Suture Technique

Prof. Dr. Paulo Fernandes Retto, Portugal

"Dr. Angle would be glad to know that contemporary orthodontics has a professional as Chris Chang!"

Digital Orthodontics, OBS & VISTA

Day 4 **Keynote workshop** (Optional)

by Newton's A team

1. patient clinical records management
2. patient communication presentation
3. Basic animations and visual aids

Dr. Rungsi Thavarungkul, Thailand

"If you think this is a computer course that will show you step–by–step how to use the application, please reconsider. If you want to improve communication in your practice, and with patients, this 8–hour course is definitely worth it."

KEYNOTE

THE LECTURER

Dr. Chris Chang

CEO, Beethoven Orthodontic and Implant Group. He received his PhD in bone physiology and Certificate in Orthodontics from Indiana University in 1996. As publisher of Journal of Digital Orthodontics-*A journal for Interdisciplinary dental treatment*, he has been actively involved in the design and application of orthodontic bone screws.

Asymmetric Class II Malocclusion with Constricted Arches, Open Bite, and Mandibular Retrusion: Etiology and Treatment with Clear Aligners

Abstract

***History**: A 27-year-old female presented for evaluation with a chief complaint (CC) of crooked front teeth with gummy smile.*

***Diagnosis**: Class II malocclusion was associated with dental crowding, overjet, anterior open bite, and a gummy smile in maxillary buccal regions. Periodontal evaluation revealed anterior recession and moderate bone loss in the anterior segments of both arches. There were problems with chewing and maximum interdigitation was uncomfortable due to a functional retrusion of the mandible on closing. The Discrepancy Index (DI) was 16.*

***Etiology**: Inadequate arch width, open bite and functional retrusion of the mandible was apparently due to childhood development problems. Inadequate functional loading of the dentition (soft diet) and a nocturnal airway problem resulted in aberrant soft tissue posturing of the lips and tongue.*

***Treatment**: Stabilize the periodontal deterioration with scaling, oral prophylaxis and hygiene instruction. Utilize a series for clear aligners to expand both arches to correct crowding, and extrude incisors in anterior segments to correct the open bite. Correct the Class II discrepancy by allowing more anterior posturing of the mandible to resolve the functional retrusion. Improve the posterior gummy smile with maxillary arch expansion, and increased axial inclination of the posterior segments.*

***Outcomes**: Crowding was corrected in both arches with expansion, and there was a slight increase in lip protrusion. Openbite was corrected with extrusion and retraction of the incisors. Bone loss in the anterior segments was stabilized. The maxillary molars were retracted to resolve the Class II discrepancy. The Cast-Radiograph Evaluation (CRE) score was 15.*

***Conclusion**: Class II crowded malocclusion with anterior open bite (DI 16) was corrected to a pleasing dentofacial result (CRE 15) by eliminating a functional retrusion of the mandible. The posturing of the mandible should be evaluated periodically to determine if a centric occlusion (CO) to centric relation (CR) discrepancy occurs after treatment. (J Digital Orthod 2019;55:26-39)*

Key words:
Invisalign®, clear aligner treatment, anterior open bite, gummy smile, severe crowding, non-extraction treatment, functional retrusion of the mandible

History and Etiology

A 27-year-old female presented for orthodontic consultation to evaluate posterior gummy smile, crowding in both dental arches, anterior open bite, and compromised dentofacial esthetics. The lower incisors were tipped labially, but lip protrusion was within normal limits (*WNL*). The upper dental midline was deviated 1mm to the left and the occlusal plane was canted to the right. Gingival recession was noted on the labial surface of the upper canines. The intraoral examination showed asymmetric buccal relationships, Class I on the left and Class II on the right (*Fig. 1*). Facial analysis identified a convex profile (*Fig. 1*) due to retrusion

Dr. Diego Peydro Herrero,
Director, Clínica Dental Peydro, Valencia, Spain
Director of Master COIP. International Master Class in Invisalign Technique
Master Class of Beethoven Invisalign International Course (Left)

Dr. Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center)

Dr. W. Eugene Roberts,
Editor-in-chief, Journal of Digital Orthodontics (Right)

Fig. 1: Pre-treatment facial and intraoral photographs show open bite, midline discrepancy, and unesthetic maxillary anterior dentition.

of the mandible. Smile analysis revealed a slight gummy smile in the buccal regions. Crowding was 6mm in the upper arch and 3mm in the lower. The panoramic radiograph (*Fig. 2*) revealed a moderate loss of alveolar crest height in the upper and lower anterior segments. The temporomandibular joint (*TMJ*) function was within normal limits. There was no history of pain. Retrusive posturing of the mandible in maximum interdigitation was due to posterior deflection of the right lateral incisors (*Fig. 1*). A lateral cephalometric radiograph confirmed mandibular retrusion (*SNA 82˚, SNB 78˚, and ANB 4˚*) that was associated with a steep mandibular plane angle (*SN-MP 36˚*). The lower incisors were labially inclined (*L1-MP 98˚*) and both lips were retrusive (*-4mm/-1mm to the E-Line*) (*Fig. 2*). An intraoral scan of the malocclusion is shown in Fig. 3. The ABO Discrepancy Index (*DI*)[1] was 16 points as shown in the subsequent worksheet. Similar to a previous complex malocclusion treated with clear aligners,[2] the pattern of attachments was carefully planned (*Fig. 4*) to achieve a pleasing outcome (*Fig. 5*). Clincheck® details contributed to an excellent final occlusion (*Figs. 6 and 7*). Radiographic documentation of the

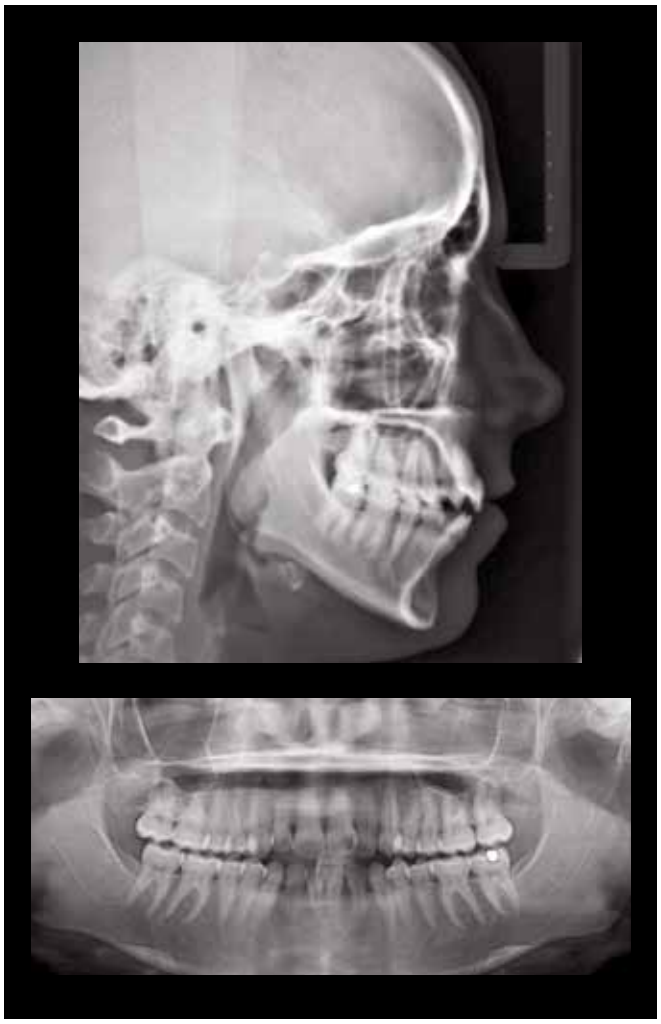

Fig. 2:
Pre-treatment lateral cephalometric and panoramic radiographs

Fig. 3:
Images captured by iTero intraoral scanner at the start of the treatment.

Fig. 4:
After 20 days of treatment with two initial aligners, different attachments are selected to move teeth in accordance with the treatment goals.

Fig. 5: Post-treatment facial and intraoral photographs

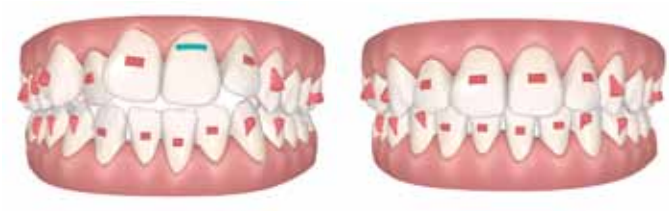

Fig. 6:
First Clincheck® proposed by Invisalign was not accepted. Seven modifications were made including extrusive movement for only in lateral incisors to level them with central incisors. Central incisor attachments were removed to improve aesthetics.

Fig. 7: Clincheck® Final outcome

treatment is provided in Fig. 8 and superimposed cephalometric tracings are in Fig. 9.

Etiology

Consideration of the etiology is an important prerequisite for designing an efficient treatment plan with good potential for stability. This acquired malocclusion[3] reflected inadequate arch width development, due to the reduced occlusal loading (*soft diet*) during childhood.[4,5] The anterior open bite is consistent with low tongue posture associated with nocturnal airway deficiency[6] and/or non-nutritive sucking habits.[7] Low tongue posture is common during the childhood years when the pharyngeal lymphoid tissue is hypertrophied. Inadequate development of the mandibular elevator muscles[8,9] is associated with excessive facial height (*Fig. 1*). Since the major etiologic factors for arch constriction occurred in childhood, bimaxillary arch expansion was indicated to achieve appropriate

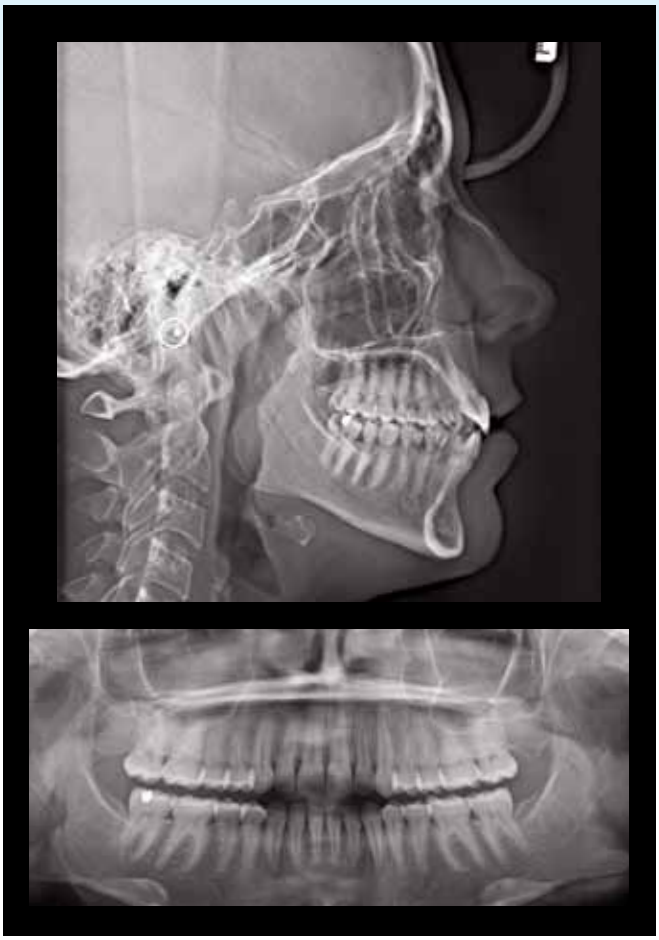

Fig. 8:
Post-treatment lateral cephalometric and panoramic radiographs

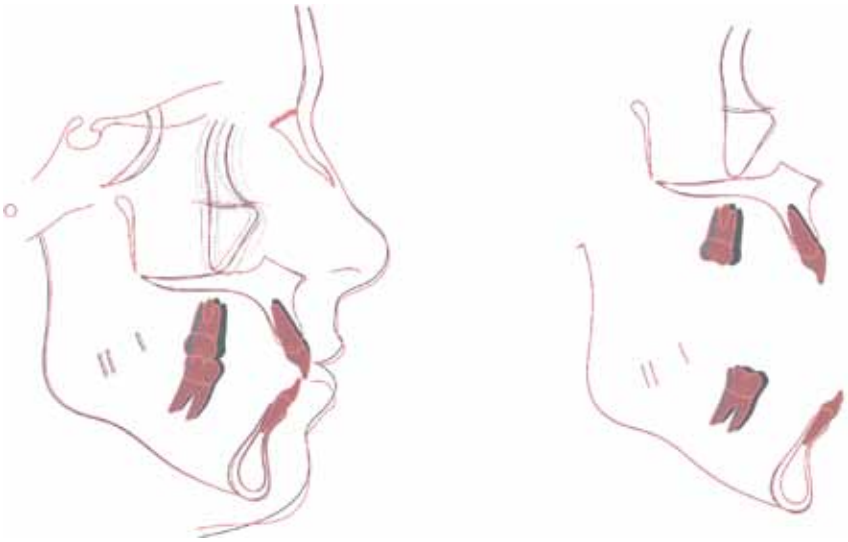

Fig. 9:
Superimposed cephalometric tracings show dentofacial relationships before (black) and after (red) treatment. Anterior cranial base superimposition on on the left. The maxillary and mandible superimpositions are on the upper right and lower right, respectively.

adult morphology. The patient's preference for non-extraction treatment with clear aligners was considered realistic.

Treatment Objectives

Consistent with the etiology of the problem(s), treatment objectives for Invisalign® (*Align Technology, San Jose CA, USA*) system clear aligners were:

1. Align, level, and expand the dentition of both dental arches.[10]
2. Correct the canine and molar Class II malocclusion.[11,12]
3. Eliminate the open bite and provide proper overbite by eliminating the functional, mandibular retrusion and allowing the mandible to posture more anteriorly.
4. Resolve crowding arches expansion and enamel stripping as needed.
5. Improve the esthetics of the smile.[13,14]
6. Expand the maxillary arch to improve the posterior gummy smile.
7. Coordinate the dental midlines with incisor alignment and differential enamel stripping as needed.

Maxilla (all three planes):

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

Mandible (all three planes):

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

Maxillary Dentition

- A - P: *Maintain*
- Vertical: *Extrude incisors*
- Inter-molar / Inter-canine Width: *Expand*

Mandibular Dentition

- A - P: *Retract lower incisors*
- Vertical: *Extrude*
- Inter-molar / Inter-canine Width: *Expand to coordinate with the upper arch*

Facial Esthetics

- Improve facial convexity and lip protrusion by correcting the functional retrusion of the mandible.
- Reduce posterior maxillary gummy smile[15,16] by correcting dental alignment with modest buccal tipping of the maxillary posterior segments.
- Reduce or eliminate buccal corridors by expanding the dental arches.

Treatment Plan

An iTero® Element™ intraoral scanner (*Align Technology, San Jose CA, USA*) documented the dental malocclusion (*Fig. 3*). A non-extraction approach was indicated to expand, align and level both dental arches. Arch expansion with differential

enamel stripping was coordinated for resolving the asymmetric Class II buccal relationship on the right. Incisal alignment, buccal expansion and incisal extrusion were used to close the open bite, and reduce the posterior gummy smile. Facial balance was improved with a more protrusive posture of the mandible after maxillary alignment was achieved.

Two Phase Treatment: Use 37 aligners changed every 10 days to correct incisal interference and expand the transverse dimension of the maxilla so the mandible can assume an unrestrained anterior position. Correct the open bite with extrusion of the upper and lower incisors. Beginning with aligner 26, use Class II elastics for at least 20 hours per day from precision cuts on both upper canines and both lower first molars (*3/16-in 6½-oz*). A second phase refinement (*re-boot*) procedure produced 10 aligners that were changed every 7 days to detail the occlusion. Continue elastics to control the overjet and optimize posterior interdigitation.

Appliances and Treatment Progress

The Invisalign® System was used for intermaxillary treatment as previously described.[17,18] For the prescribed treatment, a total of 47 aligners were used, supplemented with Class II elastics (*3/16-in 6½-oz*) for at least 20 hours per day. The latter were attached through slits in the aligners from stage 26. Treatment began when the first two aligners were delivered to the patient with instructions to wear them 10 days each for 22 hours a day. The aligners were removed only for eating and brushing. The two initial aligners were programmed for expansion and labial tipping, but not extrusion or rotational movements. At the second appointment on day 20, attachments were bonded on the dentition (*Fig. 4*) with Tetric EvoCeram (*Ivoclar Vivadent, Inc. NY, USA*) according to the following prescription.

MAXILLARY ARCH: nomenclature is according to quadrant (*1-4*) and tooth number (*1-6*):

- 1.6 Horizontal gingival beveled 3mm
- 1.5 Optimized for rotation
- 1.4 Optimized for rotation
- 1.3 Optimized for rotation and extrusion, precision cut for elastics
- 1.2 Optimized for extrusion
- 1.1 Horizontal gingival beveled 3mm on the palatal surface
- 2.6 Horizontal gingival beveled 4mm
- 2.5 Optimized for rotation
- 2.3 Optimized for rotation, precision cut for elastics
- 2.2 Optimized for extrusion
- 2.1 Horizontal gingival beveled 3mm on the palatal surface

MANDIBULAR ARCH: per tooth, according to quadrant (*1-4*) and tooth number (*1-6*):

- 3.6 Vertical 3mm, precision cut for elastics
- 3.4 Optimized for rotation
- 3.3 Optimized for rotation
- 3.1 Optimized for extrusion
- 4.6 Vertical 3mm, precision cut for elastics
- 4.5 Optimized for rotation
- 4.4 Optimized for rotation
- 4.3 Optimized for rotation
- 4.1 Optimized for extrusion

After placing the attachments, aligners 3-6 were delivered with instructions to wear them 10 days each, to expand the arches, and correct dental rotations. No extrusive movement was planned at this stage. Interproximal reduction (*IPR*) (*Fig. 4*) was performed in the lower arch on the third appointment before delivery of aligner 7. Each contact point from distal 4.3 to distal 3.3 underwent an average reduction of 0.3mm in order to align the incisors, reduce lower incisor proclination, increase lingual root torque and create enough overjet to resolve the Class II relationship. At the same appointment, aligners 7-17 were delivered to the patient to be worn 10 days each. The same process continued until aligner 22 was delivered to the patient, and elastic traction were initiated for at least 20 hours a day: bilateral 3/16-in 6½-oz elastics from precision cuts on both upper canines to precision cuts on both lower first molars.

The patient continued changing the aligners every 10 days. The movements programmed involved mainly expansion, slight buccal tipping of molars and premolars, rotation correction, extrusion of the incisors, and creation of adequate overjet to resolve the Class II buccal segments. Aligners 26-37 were programmed to simultaneously produce 1.5mm of extrusion of the upper incisors and slight intrusion of the upper molars.

The first phase of the treatment was completed up through aligner 37. A second scan was performed to plan the second phase of aligners for final detailing with 10 aligners changed every 7 days and Class II elastics as before.[19] After 16 months of active treatment the clinical objectives were achieved, and all attachments were removed. The patient wore the last aligner passively for 1 month without elastics in order to stabilize the final position.

Results achieved

Post-treatment documentation with photographs (*Fig. 5*), radiographs (*Fig. 8*), cephalometric measurements (*Table 1*), and superimposed tracings (*Fig. 9*) indicated that all the incisors were extruded and retracted (*Fig. 9; Table 1*). The final result was an optimal outcome that was very close to the tooth movement planned with the 3D Clincheck® (*Fig. 9*). The superimposed tracings showed less change in the position of the mandible than anticipated, so most of the malocclusion correction was due to aligner tooth movement and maxillary arch expansion.

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	82°	82.5°	0.5°
SNB° (80°)	78°	79°	1°
ANB° (2°)	4°	3.5°	0.5°
SN-MP° (32°)	36°	36°	0°
FMA° (25°)	29°	29°	0°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	4 mm	4.5 mm	0.5 mm
U1 To SN° (110°)	107°	104.5°	2.5°
L1 To NB mm (4 mm)	8 mm	7.5 mm	0.5 mm
L1 To MP° (90°)	98°	93°	5°
FACIAL ANALYSIS			
E-LINE UL (2-3 mm)	-4 mm	-3.5 mm	0.5 mm
E-LINE LL (1-2 mm)	-1 mm	-1 mm	0 mm
%FH: Na-ANS-Gn (53%)	58%	58.5%	0.5%
Convexity: G-Sn-Pg' (13°)	13.5°	12.5°	1°

■ *Table 1: Cephalometric summary*

Post-treatment intra- and extraoral photographs show satisfactory smile esthetics and occlusion were achieved (*Fig. 5*). The outcome was near ideal: Class I occlusion, improved axial inclination of all incisors, good alignment and leveling in both arches, and good overjet and overbite relationships. The ABO Cast-Radiograph Evaluation (*CRE*) score was 15.

Maxilla (all three planes):

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

Mandible (all three planes):

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

Maxillary Dentition

- A - P: *Retracted incisors*
- Vertical: *Extrude incisors*
- Inter-molar / Inter-canine Width: *Expanded*

Mandibular Dentition

- A - P: *Retracted lower incisors*
- Vertical: *Extruded incisors*
- Inter-molar / Inter-canine Width: *Expanded*

Retention

The patient used the last aligners for 1 month, and then a new scan was performed to make Vivera™ retainers (*Align Technology, San Jose, CA*). She was instructed to use them every night while sleeping.

Discussion

The present case report shows that anterior open bite can be corrected in an efficient manner using the Invisalign®. It is important to understand that the doctor must perform a detailed diagnosis, and then treatment plan the sequence of movements required to achieve the correction. Inadequate or inaccurate diagnosis and treatment planning are common errors.

The initial treatment plan proposed by Invisalign® technicians was to extrude the upper incisors

with no change in the maxillary arch width. They suggested placing optimized extrusion attachments on the central and lateral incisors in both arches for extrusion of >3mm (*Fig. 6*). This treatment plan was not accepted because it would worsen the gummy smile. It is ultimately the orthodontist's responsibility to make an accurate diagnosis and devise an effective treatment plan. For technicians the goal is a good dental alignment, but the doctor realizes the result must be pleasing relative to the soft tissue contours. An appropriate treatment plan is a carefully defined sequence of tooth movements that achieves treatment objectives to produce a predictable outcome.

Five modifications were entered to revise the initial Clincheck®. Expand both dental arches, perform interproximal reduction of the lower incisors, and modify the position of some attachments, particularly the optimized extrusion attachments on both upper central incisors. They were changed to horizontal gingival beveled attachments on the palatal surfaces to achieve a more esthetic outcome.

Increasing the expansion of the upper arch allowed the mandible to rotate anteriorly to help close the anterior open bite and resolve the Class II buccal segments. IPR was preformed on the lower anterior segment to resolve crowding and reduce proclination of the lower incisors. In addition the IPR was used for increasing root torque on lower canines and incisors. It was also useful for closing black triangles between the incisors due to the moderate bone loss. Deviation of the upper midline was obtained by achieving a symmetrical shape (*Fig. 7*).

Cephalometric superimpositions showed little change in facial form, but there was adequate extrusion and retraction of the incisors to correct the open bite (*Fig. 9*). Maxillary molars were retracted to correct the Class II relationship. The compensations to achieve an optimal outcome, despite a lack of substantial changes in facial form, was probably achieved via the finishing refinement to produce the last 10 aligners. It is important to realize that all continuous arch mechanics (*archwires and aligners*) are indeterminate mechanics, meaning the tooth movement due to applied loads cannot be calculated precisely.[20] Treatment planning is very important for achieving the desired outcomes, but midcourse compensations are usually necessary to correct for unanticipated results. That requires the skill of a well trained orthodontist to direct the sophisticated technology required.

Conclusion

Orthodontic mechanics delivered by the Invisalign® System (*Align Technology, San Jose, CA, USA*) is capable of resolving a complex malocclusion with substantial crowding and open bite. This case report demonstrates the importance of a detailed and accurate diagnosis, with a sequential treatment plan, to implement a predictable sequence of movements. Although the manufacturer provides a service to design a sequence of movements, it is the orthodontist who is ultimately responsible for treatment planning and approving the changes with the Clincheck® software. Performing a predictable sequence of movements and a well-planned finishing refinement led to a successful

outcome. With a careful diagnosis, treatment plan and finishing refinement, it is possible to achieve excellent results in terms of occlusion, function, and dentofacial esthetics.

Acknowledgement

Thanks for Dr. Lomia Lee for coordinate with DI & CRE worksheets, as well as the cephalometric tracings and evaluation.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 16

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 = 2

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 = 8

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 = 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 = 2

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° _____ x 1 pt. = _____

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

SN-MP

≥ 38° = 2 pts.

Each degree > 38° _____ x 2 pts. = _____

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 0

OTHER (See Instructions)

Supernumerary teeth	_____ x 1 pt. =	_____
Ankylosis of perm. teeth	_____ x 2 pts. =	_____
Anomalous morphology	_____ x 2 pts. =	_____
Impaction (except 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	_____ x 2 pts. =	_____

Identify:

Total = 0

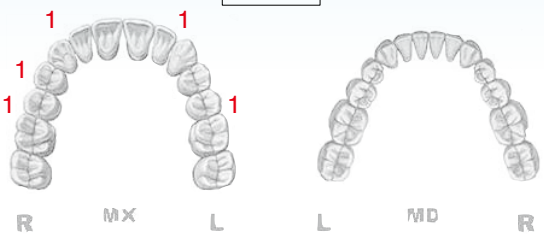
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 15

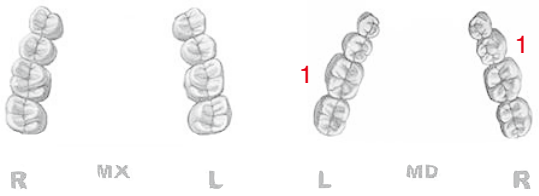
Alignment/Rotations

5



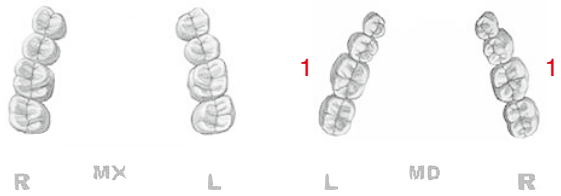
Marginal Ridges

2



Buccolingual Inclination

2

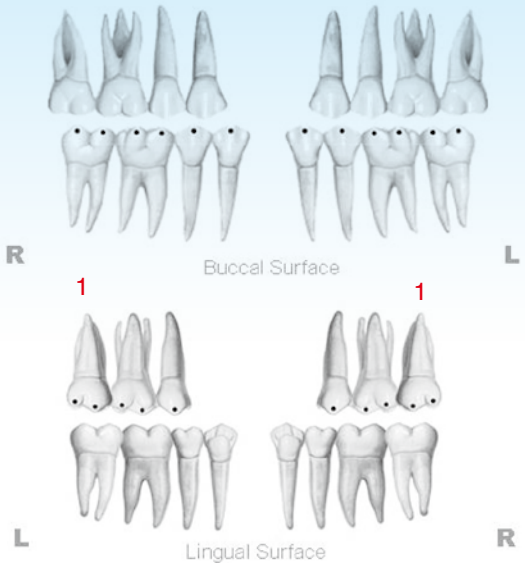


Overjet

0

Occlusal Contacts

2

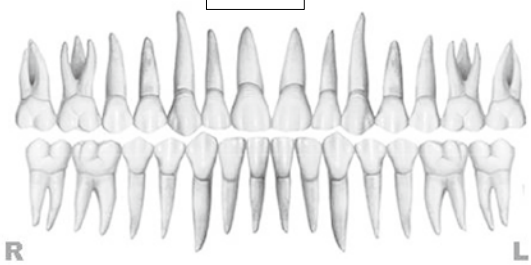


Occlusal Relationships

0

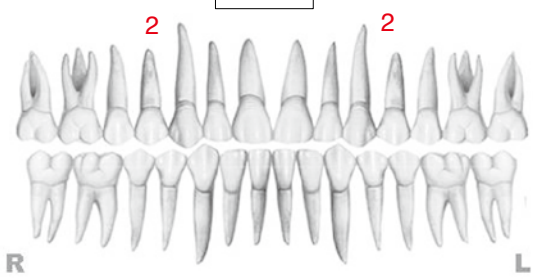
Interproximal Contacts

0



Root Angulation

4



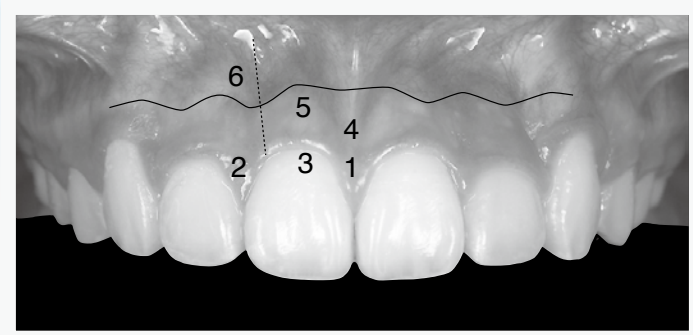
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 3

1. Pink Esthetic Score

Total = 1

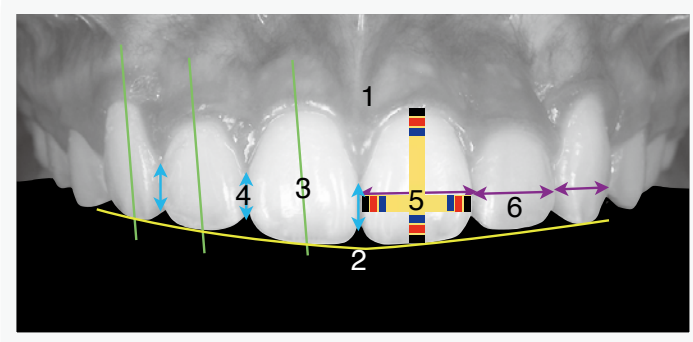


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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 = 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

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

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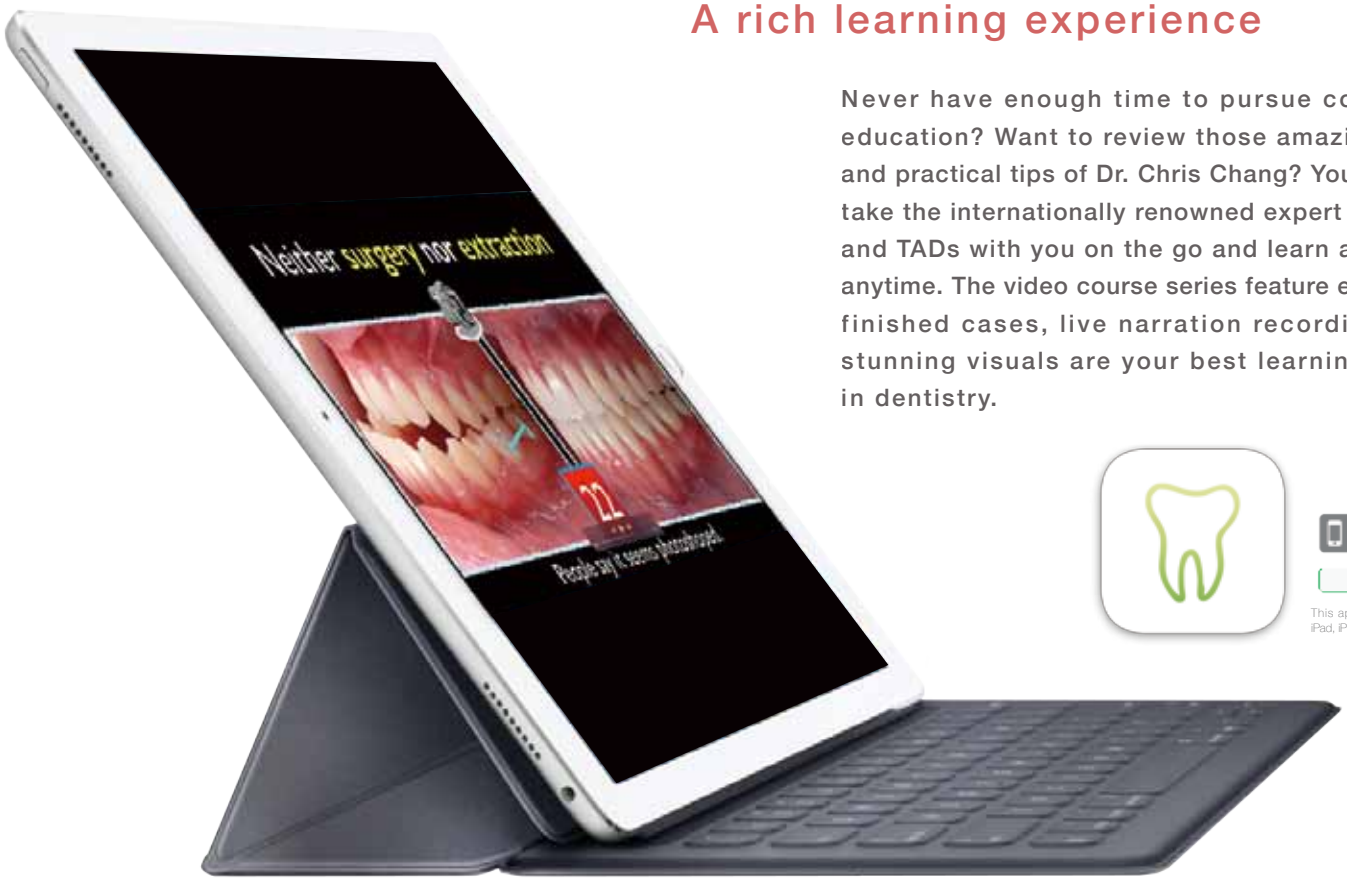

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2019~2020 第十一年度

貝多芬 矯正精修班

時間：週二上午 9:00-12:00
地點：金牛頓教育中心（新竹市建中一路25號2樓）

上課日期：

2020

8/27、9/10、10/22、11/12、12/10
1/14、2/25、3/24、4/14、5/19、6/16

- 09:00 ~ 10:00　精選文獻分析
- 10:00 ~ 10:30　精緻完工案例
- 10:50 ~ 12:00　臨床技巧及常犯錯誤分享

全新的第十一年度 2019-20 貝多芬精修班， 是由國際知名講師張慧男醫師主持，並偕同貝多芬牙醫團隊住院醫師群共同主講。

每月一次的課程之中，包含了：

1. 精選矯正權威期刊 AJODO 的文章做文獻分析與評讀。
2. 精緻完工 ABO 案例報告，其中因應數位矯正的世界趨勢，Insignia 與 Invisalign 病例為課程探討的主要內容之一。
3. 分享臨床上常犯的錯誤以及解決方法。

2019-20 貝多芬精修班內容豐富精彩，讓您經由每個月一次的課程，在面對各式的臨床案例時，更能游刃有餘、得心應手。

學習目的：

研讀最新趨勢文章可以窺知世界文獻公認的治療方式，而藉由評論文章的優缺點不僅能夠訓練判斷與思考能力，更可以清楚比較作法上的不同，達到完整理解治療方向、內容與穩定性的目標。

報名專線：03-5735676＃201，蔡佳汶

2019 CDABO Case Report of the Year Award

Severe Unilateral Scissors-bite with a Constricted Mandibular Arch: Bite Turbos and Extra-alveolar Bone Screws in the Infra-zygomatic Crests and Mandibular Buccal Shelf

Abstract

A 33-year-old woman had a chief complaint of difficulty chewing, caused by a constricted mandibular arch and a unilateral full buccal crossbite (scissors-bite or Brodie bite). She requested minimally invasive treat- ment but agreed to anchorage with extra-alveolar temporary anchorage devices as needed. Her facial form was convex with protrusive but competent lips. Skeletally, the maxilla was protrusive (SNA, 86°) with an ANB angle of 5°. Amounts of crowding were 5 mm in the mandibular arch and 3 mm in the maxillary arch. The mandibular midline was deviated to the left about 2 mm, which was consistent with a medially and inferiorly displaced mandibular right condyle. Ectopic eruption of the maxillary right permanent first molar to the buccal side of the mandibular first molar cusps resulted in a 2-mm functional shift of the mandible to the left, which subsequently developed into a full buccal crossbite on the right side. Treatment was a conservative nonextraction approach with passive self-ligating brackets. Glass ionomer bite turbos were bonded on the occlusal surfaces of the maxillary left molars at 1 month into treatment. An extra- alveolar temporary anchorage device, a 2x12-mm OrthoBoneScrew (Newton A, HsinChu City, Taiwan), was inserted in the right mandibular buccal shelf. Elastomeric chains, anchored by the OrthoBoneScrew, extended to lingual buttons bonded on the lingually inclined mandibular right molars. Cross elastics were added as secondary uprighting mechanics. The maxillary right bite turbos were reduced at 4 months and removed 1 month later. At 11 months, bite turbos were bonded on the lingual surfaces of the maxillary central incisors, and an OrthoBoneScrew was inserted in each infrazygomatic crest. The Class II relationship was resolved with bimaxillary retraction of the maxillary arch with infrazygomatic crest anchorage and inter maxillary elastics. Interproximal reduction was performed to correct the black interdental spaces and the anterior flaring of the incisors. The scissors-bite and lingually inclined mandibular right posterior segment were sufficiently corrected after 3 months of treatment to establish adequate intermaxillary occlusion in the right posterior segments to intrude the maxillary right molars. The anterior bite turbos opened space for extrusion of the posterior teeth to level the mandibular arch, and the infrazygomatic crest bone screws anchored the retraction of the maxillary arch. In 27 months, this difficult malocclusion, with a Discrepancy Index score of 25, was treated to a Cast-Radiograph Evaluation score of 22 and a pink and white esthetic score of 3. (Reprinted with permission from Am J Ortho Dentofacial Ortho 2018;154;554-69). (J Digital Orthod 2019;55:44-62)

Key words:

Scissors-bite, Brodie bite, buccal crossbite, lingually inclined lower molars, ectopic eruption, maxillary protrusion, lip protrusion, cross elastics, occlusal bite turbo, extra-alveolar anchorage, mandibular buccal shelf, mandibular rotation, infra-zygomatic crest, inter-proximal reduction, bone screws, TADs

Introduction

A buccal crossbite is a malocclusion when the palatal cusp of the maxillary tooth is buccal to the buccal cusp of the opposing mandibular dentition; a lingual crossbite is when the maxillary buccal cusp is lingual to the buccal cusp tip of the opposing mandibular tooth. Brodie[1] defined a malocclusion as a "*Brodie bite*" or "*Brodie syndrome*" when the mandibular jaw "*telescoped*" within the upper arch, i.e. the mandibular teeth

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Editor, Journal of Digital Orthodontics (Left)
Dr. Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center)
Dr. W. Eugene Roberts,
Editor-in-chief, Journal of Digital Orthodontics (Right)

were completely contained within the upper arch. Sim[2] preferred the more generic term "*bilateral buccal crossbite,*" but van der Linden and Boersma[3] introduced the term "*scissors bite*" for the total "*endo-occlusion*" of the mandibular posterior teeth. Moyer[4] characterized a bilateral buccal crossbite as a skeletal disharmony between the mandible and maxilla. If the scissors-bite is bilateral, the mandible may be functionally retruded, and if it is unilateral, there is often a cant to the occlusal plane and a lateral deviation of the mandible.[4,5]

Fig. 1: Pretreatment facial and intraoral photographs

Diagnosis and Etiology

The patient's chief concern was the inability to chew on the right side. Her medical and dental histories were noncontributory. Facially, she had a convex profile with protrusive lips (*Fig. 1*), but her dental smile line was acceptable. The intraoral examination showered a scissors-bite on the right, a lingually inclined mandibular right posterior segment, Class I molar relationship on the left, an anterior deep overbite, canting of the occlusal plane down on the right, and mandibular anterior crowding (*Fig. 1*). The mandible deviated to the left on closure resulting in a dental midline shift 2 mm to the left (*Fig. 2*). The dental casts showed that the maxillary right posterior teeth impinged on the mandibular gingiva, and there was no intercuspation of the right posterior segment (*Figs. 3 and 4*).

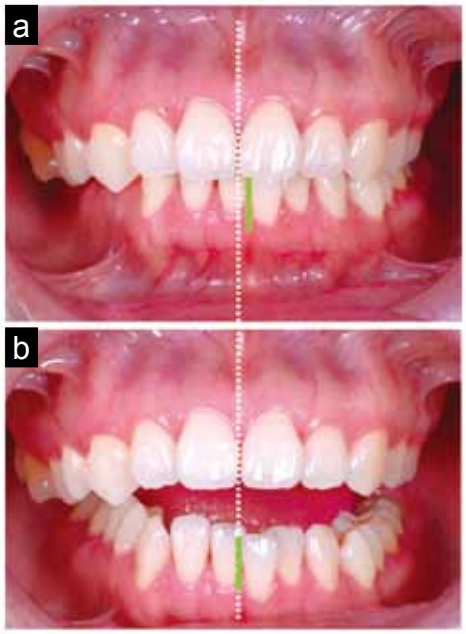

Fig. 2:
(a) Mandibular dental midline was deviated 2-mm to the left when closed.
(b) The midline was coincident when the bite was opened.

The pretreatment cephalometric analysis showed a protrusive pattern of the maxilla, incisors, and lips (*Fig. 5; Table 1*). The panoramic radiograph showed extrusion of the mandibular right posterior segment (*Fig. 6*) consistent with the unilateral scissors-bite. The temporomandibular joint (*TMJ*) radiographs showed no significant difference in the morphology or kinematics (*movement*) of the right and left condyles

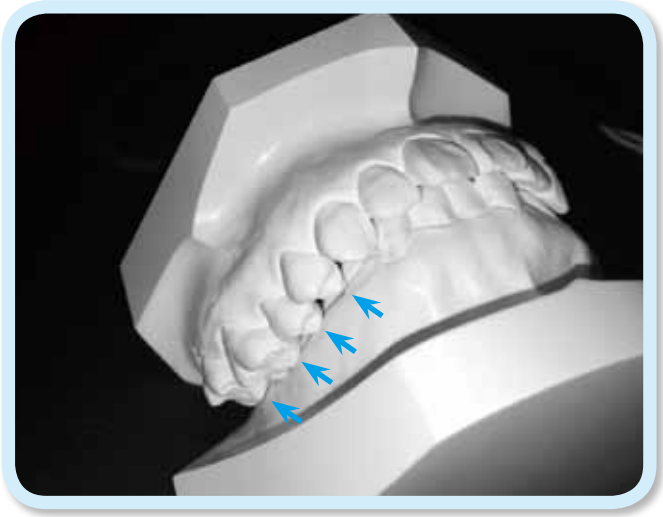

Fig. 3:
Dental casts showed the maxillary right premolars and molars impinging on the mandibular gingiva.

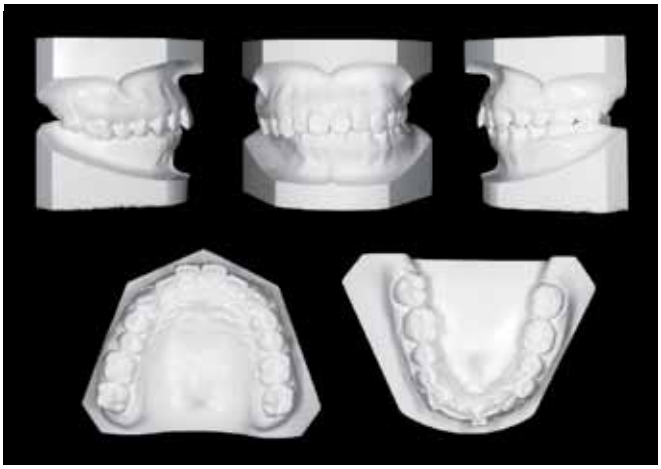

Fig. 4: Pretreatment dental models (casts)

Fig. 5: Pretreatment lateral cephalometric radiograph

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	86°	85°	1°
SNB°	81°	81°	0°
ANB°	5°	4°	1°
SN-MP°	34°	35°	1°
FMA°	27°	28°	1°
DENTAL ANALYSIS			
U1 To NA mm	4 mm	0 mm	4 mm
U1 To SN°	104°	98°	6°
L1 To NB mm	9 mm	6 mm	3 mm
L1 To MP°	100°	90°	10°
FACIAL ANALYSIS			
E-LINE UL	2 mm	1 mm	1 mm
E-LINE LL	3 mm	1 mm	2 mm

Table 1: Cephalometric summary

in the open and rest (*closed*) positions (*Fig. 7*), but the right condylar head in the rest position was more posteriorly and inferiorly positioned, which was consistent with mandibular deviation on closing (*Fig. 2*). No temporomandibular disorder (*TMD*) signs or symptoms were reported or clinically evident.

Asymmetric malocclusions such as scissors-bite may be associated with TMD,[6] and the etiology of the buccal crossbite may be genetic, congenital or developmental.[7] There was no history or morphologic evidence of a skeletal or dental anomaly, so the most likely etiology was developmental: a buccal ectopic eruption of the

Fig. 6: Pretreatment panoramic radiograph

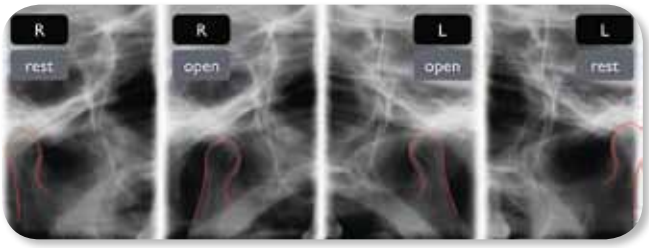

Fig. 7:
Pretreatment TMJ transcranial radiographs are shown of the right (R) and left (L) sides in the rest and open positions. The mandibular condyles are outlined in red. See texts for details.

maxillary right first molar at about age 6 years. This abnormal eruption pattern produces a functional shift of the mandible that results in the rest of the buccal segment erupting in buccal crossbite during the late transitional stage of dental development (*10-12 years*).[7] The American Board of Orthodontic (*ABO*) Discrepancy Index (*DI*) score for this malocclusion was 25 points, as shown in the supplementary worksheet 1.[8]

Treatment Objectives

(1) Correct the unilateral posterior scissors-bite.

(2) Upright the lingually inclined mandibular right buccal segment.

(3) Eliminate the occlusal cant due to the extruded maxillary right buccal segment.

(4) Achieve Class I canine and molar relationships.

(5) Correct the midline discrepancy.

(6) Produce ideal overbite and overjet relationships.

(7) Optimize the intermaxillary occlusion.

(8) Correct facial convexity and asymmetry.

Treatment Alternatives

Unilateral or bilateral scissors-bite of the entire buccal segment can be corrected with orthognathic surgery, biteplates or extensive use of interradicular (*I-R*) temporary anchorage devices (*TADs*) in both arches.[6,9-13] However, all of these approaches are complicated, because the asymmetric tooth movements necessary to finish the occlusion are challenging. No ideal dental alignments after treatment have been reported. A more conservative approach with the potential for a more ideal outcome was to reverse the etiology of scissors-bite by opening the vertical dimension of the occlusion (*VDO*) with glass ionomer bite turbos (*BTs*). With adequate occlusal clearance, the axial inclinations of the right buccal segments can be readily corrected with elastics anchored by a mandibular buccal shelf (*MBS*) bone screw (*miniscrew*) on the right side. Additional extra-alveolar (*E-A*) TADs in the infrazygomatic crest (*IZC*) are needed to correct the maxillary protrusion. Once normal bilateral occlusion is restored, optimal dental function facilitates the orthodontic finishing.

The patient was opposed to orthognathic surgery, extractions or compliance-dependent devices, but she still desired an ideal result. The conservative option with BTs and bone screws was her preference, and she was prepared for the occlusal inconvenience when the VDO was opened at the start of treatment. After an explanation of the anchorage requirements, she agreed to E-A TADs for mandibular right posterior alignment and retraction of the maxillary arch. To optimize dental esthetics, interproximal reduction was required to correct her black triangles.

Treatment Progress

An 0.022-in slot Damon Q® fixed appliance (*Ormco, Glendora, California*) with passive self-ligating (*PSL*) brackets was selected along with all specified archwires and orthodontic auxiliaries. Standard torque brackets were bonded on all teeth in the

maxillary arch. One month later, the mandibular arch was also bonded with standard torque brackets. The initial archwires were 0.014-in copper-nickel-titanium (*CuNiTi*). Two occlusal BTs were constructed with Fuji II type II glass ionomer cement (*GC America, Alsip IL*) on the maxillary left molars to increase the intermaxillary space to allow the collapsed mandibular right molars to upright with no resistance (*Fig. 8*). The mechanics to correct the scissors-bite were (*1*) an E-A MBS OrthoBoneScrew® (*OBS, 2x12-mm, Newton's A Ltd, Hsinchu City, Taiwan*) inserted in the mandibular right buccal shelf,[14-17] with two power chains connected from the miniscrew to the two buttons on the lingual side of each mandibular right molar, and (*2*) two cross elastics (*Chipmunk, 1/8-in, 3.5-oz*) applied on the maxillary right and mandibular right molars. In the 4th month, the scissors-bite was corrected, so the thickness of the occlusal BTs was progressively reduced to begin establishing a normal bilateral posterior occlusion.

As the molars uprighted, the 6-mm distance between the mandibular right miniscrew and the molar tube decreased to 0 mm (*Fig. 9*). The MBS bone screw and occlusal BTs were removed in the 5th month of treatment. The maxillary archwire was changed to 0.014x0.025-in CuNiTi to resolve the remaining rotations, begin torque control, and continue the correction of arch symmetry. In the 6th month, the archwires were changed to 0.017x0.025-in titanium-molybdenum alloy (*TMA®*) in the maxillary arch and 0.014x0.025-in CuNiTi in the mandibular arch. A lingual crossbite tendency was noted for the left molars; thus, two buttons were bonded on the palatal surfaces of the maxillary left molars to anchor the cross elastics (*Chipmunk, 1/8-in,*

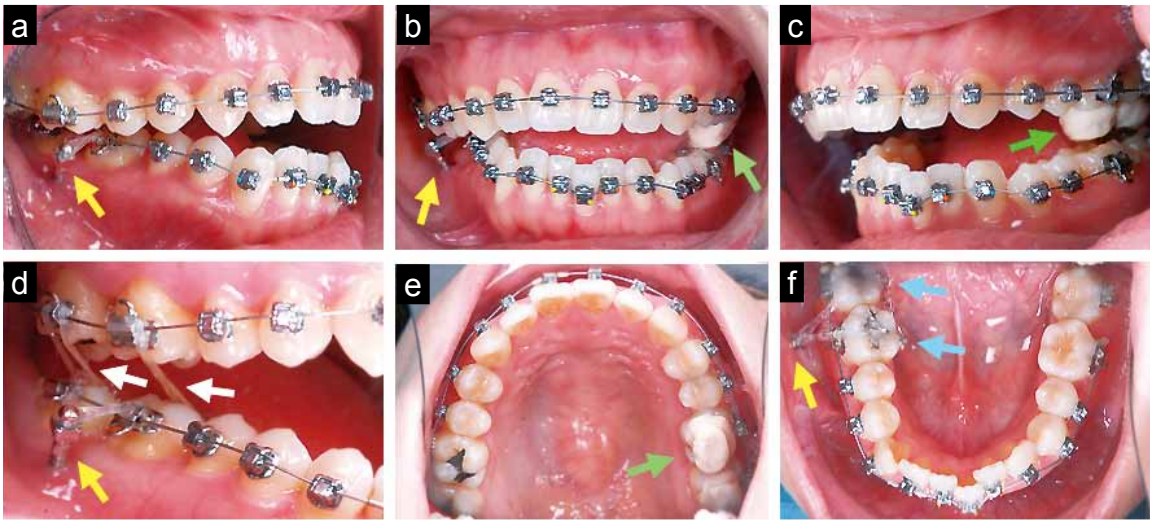

Fig. 8:

a. *In the 1st month of treatment, 0.014-in CuNiTi archwires were placed in both arches. Elastomeric chains from the lingual buttons on the mandibular right molars were activated with the MBS bone screw (yellow arrow).*

b. *BTs were added to the occlusal surfaces of the maxillary left molars (green arrow).*

c. *A buccal view shows that the bite is opened about 5-mm (green arrow).*

d. *Cross elastics supplement the lateral force (white arrows) of the elastomeric chains that are attached to the MBS bone screw (yellow arrow).*

e. *An occlusal view shows the positions of the BTs (green arrow).*

f. *Buccal force (blue arrows) from the lingual buttons on the mandibular right molars is activated by attaching the elastomeric chains to the MBS bone screw (yellow arrow).*

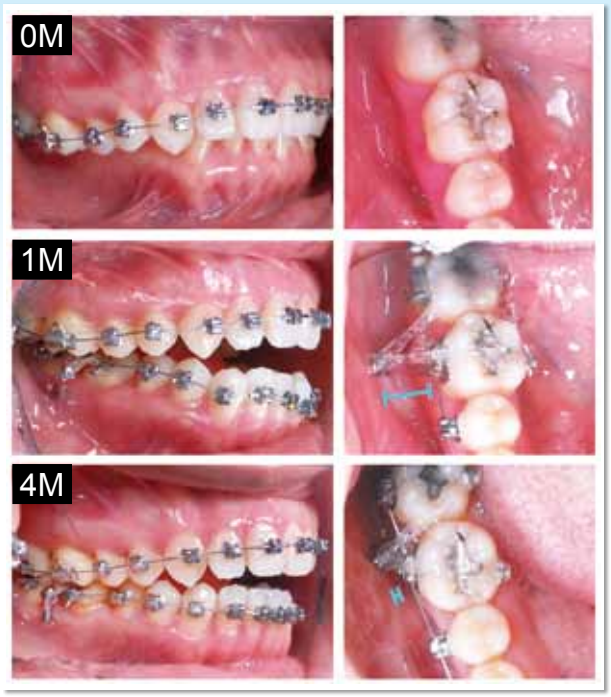

Fig. 9:
The scissors-bite is documented at the start of treatment (0M). The elastomeric chains activated by the MBS bone screw are shown at one month into treatment (1M). The blue bar shows the distance from the bone screw to the first molar is about 7 mm (middle right). At four months (4M), the molar have moved about 6mm to the buccal aspect and the distance from the molar to the bone screw is only about 1 mm (lower right).

3.5-oz). In the 7th month, the maxillary archwire was changed to 0.016x0.025-in stainless-steel (*SS*), which was adjusted to deliver progressive lingual root torque on the right premolar and molar segments to improve the overjet and intermaxillary alignment. The SS archwire was also constricted to develop a more symmetric arch form. A 0.017x0.025-in TMA archwire was placed in the mandibular arch. In the 9th month, the archwire was changed to 0.019x0.025-in SS in the maxillary arch to finalize torque control, with 0.016x0.025-in SS in the mandibular arch to establish symmetry.

In the 10th month, an openbite was noted in the left posterior segment as the bilateral posterior occlusion was established. As the lateral open bite closed, a deeper anterior overbite occurred that subsequently required BTs on the maxillary central incisors. In retrospect, it would have been wiser to further intrude the molars on the right side to close the lateral open bite on the left side. This approach would have decreased or prevented the tendency for clockwise rotation of the mandible.

As the occlusion settled after crossbite correction, the intermaxillary relationship was Class II. In the 11th month, posterior bone screws were inserted bilaterally into the maxillary extra-alveolar IZCs. Power chains were applied from the canines to the extra-alveolar IZC bone screws to improve the protrusive profile by retracting the entire maxillary dentition. Class II elastics (*Fox, 1/4-in, 3.5-oz*) and the BTs bonded on the palatal surface of the maxillary central incisors simultaneously corrected the deep overbite, anterior overjet, and Class II molar relationships.

During the detailing phase, the brackets were repositioned to correct marginal ridge discrepancies. Interproximal reduction (*IPR*) reshaped the maxillary and mandibular incisors to eliminate the black interdental spaces and increase the interproximal space between the incisors to resolve anterior flaring (*Fig. 10*). Two weeks before the completion of

Fig. 10:
The IPR procedure is shown before and after the incisors were reshaped to eliminate black interdental spaces, increase the contact area, and provide space for retraction of the anterior segment. Note that BTs were necessary on the palatal surfaces of the central incisors to control the overbite as the incisors were retracted to reduce lip protrusion.

active treatment, the maxillary archwire was sectioned distally to the canines, and continuous intermaxillary elastics (*Ostrich, 3/4-in, 2-oz*) were used to settle the posterior occlusion.[18] After 27 months of active treatment, all appliances were removed, and retention was accomplished with maxillary and mandibular clear overlay retainers. The entire treatment sequence is documented in Figs. 11a-d.

Fig. 11a:
Frontal views of the treatment sequence before treatment and after brackets were bonded on the maxillary arch (0M). Progress is shown at treatment times in months: 1M, 4M, 10M, 16M, 24M, and 27M.

Fig. 11b:
Right lateral views of the treatment sequence before treatment and after brackets were bonded on the maxillary arch (0M). Progress is shown at treatment times in months: 1M, 4M, 10M, 16M, 24M, and 27M.

Fig. 11c:
Left lateral views of the treatment sequence before treatment and after brackets were bonded on the maxillary arch (0M). Progress is shown at treatment times in months: 1M, 4M, 10M, 16M, 24M, and 27M.

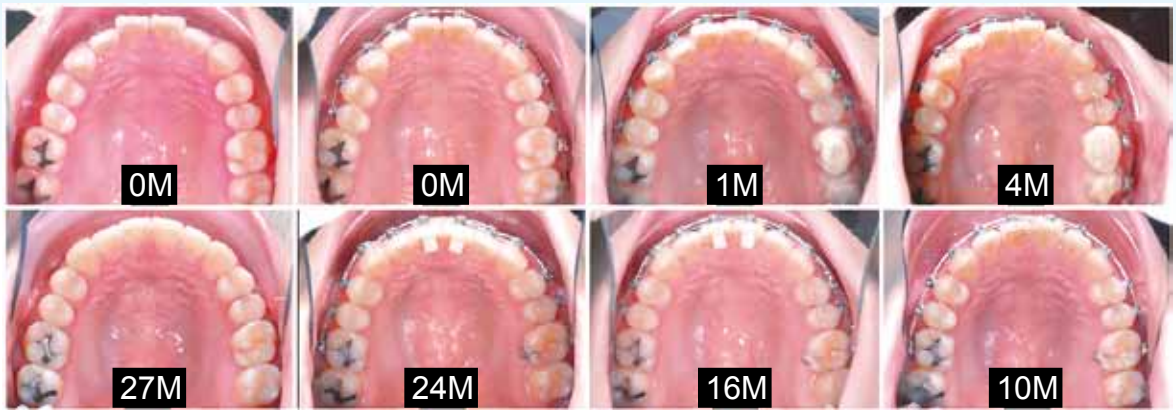

Fig. 11d:
Maxillary occlusal views of the treatment sequence before treatment and after brackets were bonded on the maxillary arch (0M). Progress is shown at treatment times in months: 1M, 4M, 10M, 16M, 24M, and 27M.

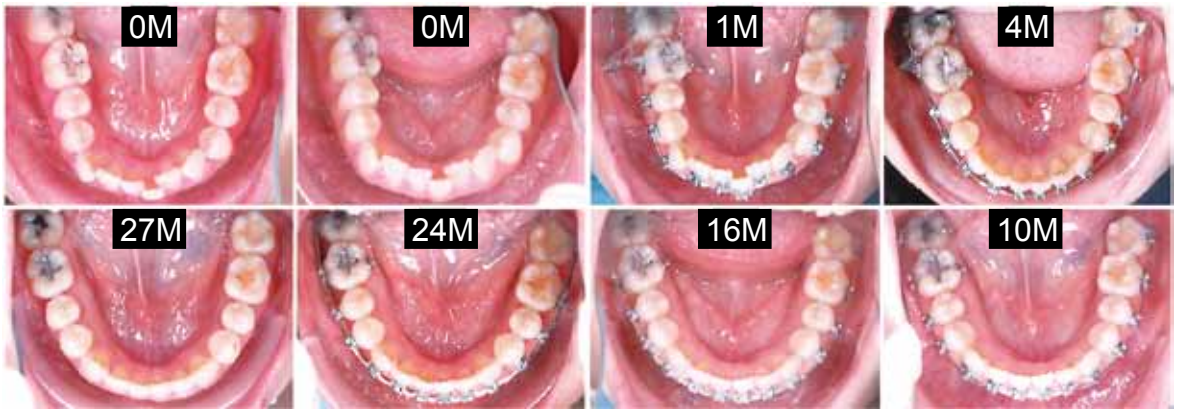

Fig. 11e:
Mandibular occlusal views of the treatment sequence before treatment and after brackets were bonded on the maxillary arch (0M). Progress is shown at treatment times in months: 1M, 4M, 10M, 16M, 24M, and 27M.

Treatment Results

The patient's convex profile was improved by retraction of the maxillary arch and protrusive lips (*Fig. 12*). The scissors-bite was successfully resolved by opening the bite, uprighting the lingually inclined buccal segment and intruding the maxillary right posterior dentition (*Fig. 13*). The subsequent anterior deep overbite and mandibular dental midline deviation were also corrected (*Fig. 14*). Near ideal dental alignment was achieved as evidenced by the ABO Cast-Radiograph Evaluation (*CRE*) score of 22 points, as shown in the supplementary worksheet 2.[19] The major residual problems were the marginal ridges discrepancies and inadequate occlusal contacts.

Fig. 12: Posttreatment facial and intraoral photographs

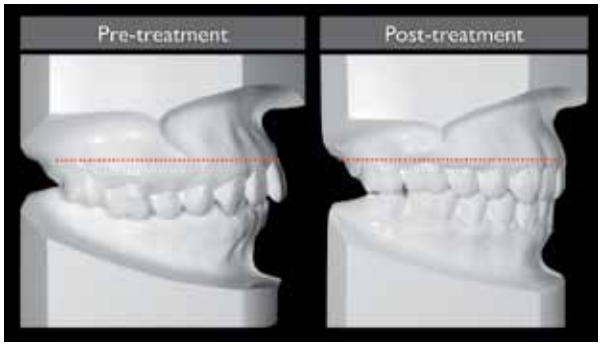

Fig. 13:
Right lateral views of the pretreatment and posttreatment dental casts show the intrusion of the maxillary right posterior teeth, relative to a dotted red line marking the plane of the desired gingival margins. Note that the mandibular right posterior teeth are not visible on the pretreatment cast.

Fig. 14: Posttreatment dental models (casts)

The posttreatment panoramic film (*Fig. 15*) showed good axial inclinations of all teeth except the mandibular molars, which had a root-mesial axial inclination that resulted in marginal ridge discrepancies (*Worksheet 2*). The cephalometric film (*Fig. 16*) and superimposed tracings (*Fig. 17*) showed that the lip protrusion was corrected. The SNA was

Fig. 15: Posttreatment panoramic radiograph

Fig. 16: Posttreatment lateral cephalometric radiograph

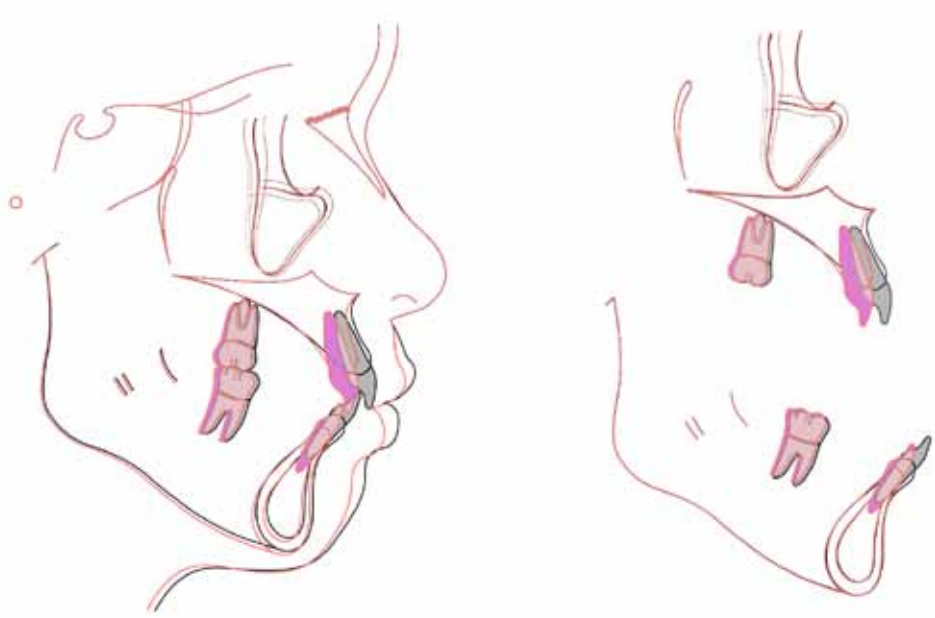

Fig. 17:
Pretreatment (black) and posttreatment (red) cephalometric tracings are superimposed on the anterior cranial base (left), the maxilla (upper right), and the mandible (lower right). The incisors were retracted and lip protrusion was reduced. Because of the poor alignment on the right side, the molars in the tracings are from the left side. Intrusion of the maxillary right buccal segment is shown in Fig. 13. See text for details.

decreased from 86° to 85° due to bone modeling during retraction of the maxillary incisors. Both SN-MP and FMA increased by 1° due to the clockwise mandibular rotation (*Table 1; Fig. 17*), which appears to reflect inadequate intrusion of the mandibular right first molar (*Fig. 15*). The maxillary incisors were retracted and extruded, and the mandibular incisors were retracted and intruded. The maxillary molars were retracted and intruded, but the mandibular molars were retracted and extruded. The posttreatment TMJ transcranial radiographs (*Fig. 18*) showed that the condylar heads returned to symmetric morphology and kinematics. The patient reported no TMD signs or symptoms before, during, or after treatment.

The Pink and White dental esthetic score[20] was 3 points, as shown in the supplementary worksheet 3. The patient was well satisfied with her esthetics and functional occlusion.

Discussion

The first consideration for scissor-bite correction is to determine whether orthognathic surgery is necessary.[13] A wide variety of orthodontic mechanics have been proposed: intermaxillary cross elastics,[6] TAD anchorage,[9,10,12,13] removable plate with a Ti-Ni wire,[11] transpalatal arch (*TPA*) with intramaxillary elastics,[21,22] quad-helix,[23] and lingual arch appliances with intramaxillary elastics.[24] The vertical overlap of a buccal crossbite requires dental intrusion or opening of the bite to correct the cusp in a fossa discrepancy. For instance, unilateral cross elastics produce an extrusive force that may result in clockwise rotation

Fig. 18:
The posttreatment transcranial radiographs of both TMJs show that the patient's condylar heads (outlined in red) are symmetric in length and shape. Morphology and kinematics are similar for both sides in the rest and open positions.

of the mandible, cant of the occlusal plane, occlusal prematurities, or an anterior open bite. In addition, cooperation is a critical factor with a removable plate[11] or cross elastics.[25]

I-R miniscrews are commonly used as skeletal anchorage because they are relatively easy to place, provide direct anchorage to intrude teeth, and do not require compliance.[10,12,25,26] However, a scissor-bite of multiple teeth with a large vertical overlap is difficult to correct with routine orthodontic mechanics, even with bone screw anchorage, especially in an adult. Therefore, most severe scissors-bite problems have been corrected with surgical orthodontics.[6,27,28]

Our patient had a scissors-bite of the maxillary right buccal segment that articulated with a lingually tipped mandibular right buccal segment. The extruded maxillary right molars and premolars impinged on the mandibular gingiva (*Fig. 3*). Orthognathic surgery is usually indicated for such a severe malocclusion. However, E-A TADs with contralateral bite turbos allowed reverse of the etiology of the malocclusion by intruding the

maxillary right buccal segment and uprighting the mandibular right buccal segment. There were three steps in the correction process:

1. **Adequate Bite Opening**: A 5-mm posterior open-bite was created with BTs to allow the buccal cusps of the mandibular right molar and premolars to pass the lingual cusps of the opposing maxillary buccal segment (*Fig. 8*). The BTs were reduced and eventually removed when the posterior overjet was corrected.

2. **Simultaneous Intrusion and Buccal Tipping**: Elastic chains attached to the lingual buttons on the mandibular right molars pass over the occlusal surfaces and connect to the MBS bone screw. Because of the archwire connecting the teeth, these mechanics intruded and uprighted the entire buccal segment (*Figs. 8 and 9*). Supplemental cross elastics provided the additional lateral force for the crossbite correction. The extrusive force on the mandibular segment because of the cross elastics was offset by the intrusive force delivered by the elastomeric chains connected to the MBS bone screw. There are three benefits favoring a MBS bone screw compared with I-R bone screw:

   a. **Prominent Head**: The OBS has a large head with deep undercuts to readily retain elastomeric chains, which produce efficient uprighting of the mandibular right segment (*Fig. 19*).

   b. **More Buccal Position**: The E-A TAD can be positioned up to 10-mm to the buccal aspect of the lingually tipped molars (*Fig. 19*). This is adequate space to upright the entire buccal segment with one bone screw. Elastic chains can be connected to both molars (*Fig. 20*) because they are connected with a archwire on the buccal surface. I-R TADs interfere with movement of the teeth, and frequent replacement would be necessary (*Fig. 19*).

   c. **Variable Head Position**: The OBS head can be positioned as close to the soft tissue as needed. The clinician can screw it in deeper if a more intrusive force component is needed (*Fig. 21*).

3. **Compatible with Cross Elastics**: An elastomeric chain anchored by an MBS bone screw provides effective intrusion of the mandibular right molars and is compatible with the simultaneous use of cross elastics. These combined mechanics uprighted the mandibular right molars 6 mm in three months (*Figs. 8 and 9*).

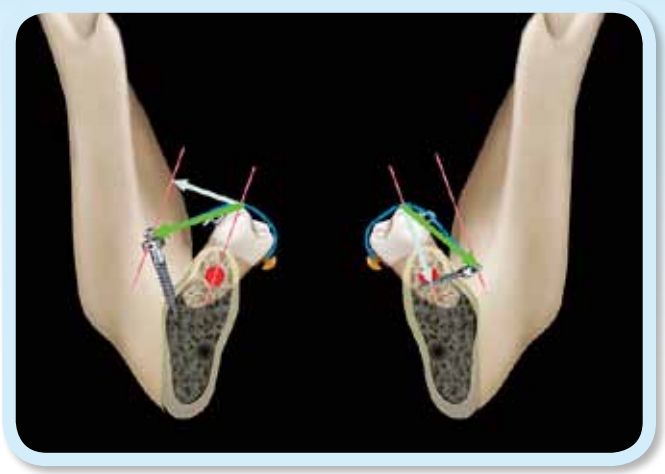

Fig. 19:
Comparing the I-R bone screw (right) with the contralateral E-A bone screw (left), it is evident that the elevated head position and more buccal position of the E-A TAD, relative to the center of rotation of the molar root (pink lines), provides a mechanical advantage for uprighting the molar (left).

A severe Class II unilateral scissors-bite was corrected with a minimally invasive approach that reversed

Fig. 20:
The E-A bone screw can be positioned buccal to the second molar or between the first and second molars. Either configuration is a viable alternative depending on the patient's anatomy because of the archwire, which transfers uprighting force to all teeth in the buccal segment.

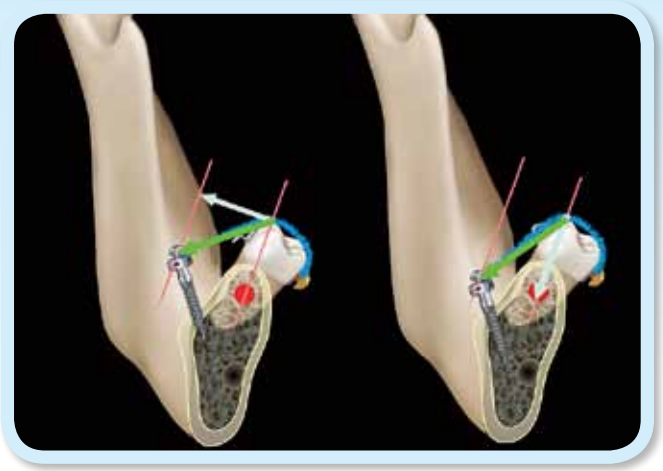

Fig. 21:
The head position height of the E-A bone screw can be controlled by the clinician. The force anchored by the higher (more superficial) bone screw head (left) delivers more buccal and less intrusive force compared with a screw head positioned more closely to the soft tissue (right).

the etiology of the malocclusion. This conservative treatment avoided extractions and orthognathic surgery. Once the transverse discrepancy was corrected, extra-alveolar IZC bone screws were used as E-A posterior maxillary anchorage to retract the entire maxillary arch. After 16 months of retraction, the patient's profile was corrected (*Fig. 22*). Her occlusion and facial esthetics were stable at 38 months after treatment (*Fig. 23*), and the second-order alignment of the dentition has continued to improve (*Fig. 24*).

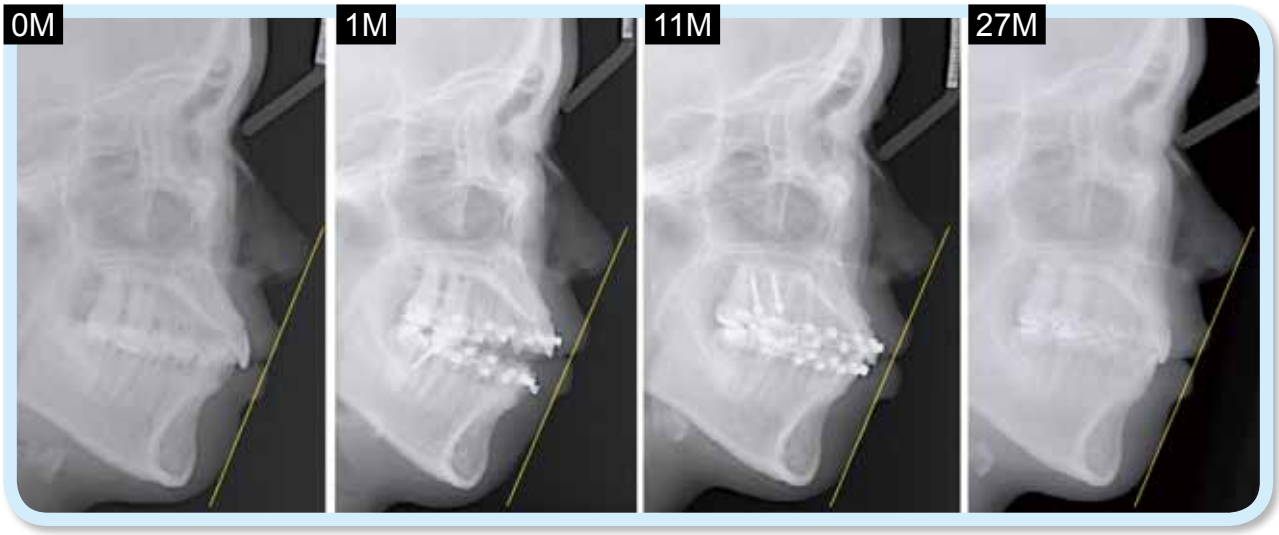

Fig. 22:
Lateral cephalometric radiographs compare lip protrusion before, during, and after treatment with the esthetic plane, a yellow line connecting the tip of the nose with the most anterior contour of the chin (Pg'). Before treatment (0M), the patient's lips were slightly protrusive. In the 1st month of treatment (1M), a 5-mm open-bite was created by the occlusal BT on the upper left side. In the 1th month (11M), more pronounced maxillary and lip protrusion was noted. Bilateral extra-alveolar IZC bone screws were placed to retract the maxillary arch. In the 27th month of treatment (27M), lip protrusion was corrected to the Na-Pg' line (esthetic plane).

Fig. 23:
Facial and intraoral photographs at the 38-month follow-up.

Fig. 24: Panoramic radiograph at the38-monthfollow-up.

Conclusions

1. E-A bone screws are a minimally invasive approach for resolving severe scissors-bite malocclusion complicated with maxillary protrusion.

2. Uprighting the mandibular right buccal segment with a MBS bone screw provided a normal occlusion to intrude the extruded maxillary molars. However, it is important to ensure that there is adequate intrusion of the maxillary and mandibular molars on the affected side to prevent opening the VDO (*clockwise rotation of the mandible*).

3. Bilateral extra-alveolar IZC bone screws were effective for reducing maxillary protrusion by retracting the entire maxillary arch.

4. Correcting axial inclinations in the buccal segments is important for preventing marginal ridge discrepancies.

Acknowledgment

Thanks to Mr. Paul Head for proofreading this article and Dr. Rungsi Thavarungkul for the beautiful illustrations.

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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 =

Total = 2

OVERBITE

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

Total = 5

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 = 2

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 = 0

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 8

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° _____ x 1 pt. = _____

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

SN-MP

≥ 38° = 2 pts.

Each degree > 38° _____ x 2 pts. = _____

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

Each degree > 99° 1 x 1 pt. = 1

Total = 2

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	3	x 2 pts. =	6

Identify: over-erupted right premolars and molars

Total = 6

IMPLANT SITE

Lip line : Low (0 pt), Medium (1 pt), High (2 pts) =_

Gingival biotype : Low-scalloped, thick (0 pt), Medium-scalloped, medium-thick (1 pt), High-scalloped, thin (2 pts) =_

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

Bone level at adjacent teeth : ≤ 5 mm to contact point (0 pt), 5.5 to 6.5 mm to contact point (1 pt), ≥ 7mm to contact point (2 pts) =_

Bone anatomy of alveolar crest : H&V sufficient (0 pt), Deficient H, allow simultaneous augment (1 pt), Deficient H, require prior grafting (2 pts), Deficient V or Both H&V (3 pts) =_

Soft tissue anatomy : Intact (0 pt), Defective (2 pts) =_

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

Total =

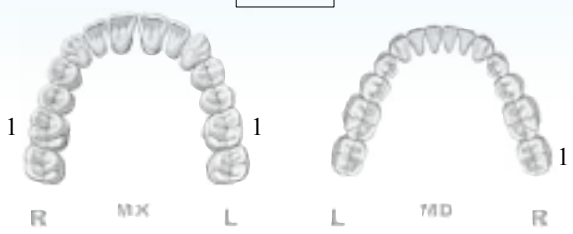
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 22

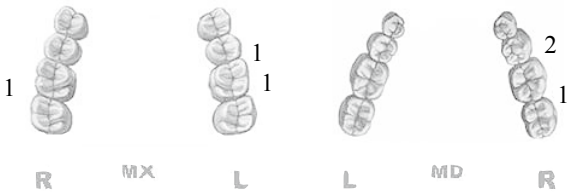
Alignment/Rotations

3



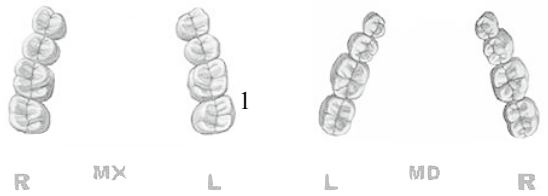
Marginal Ridges

6



Buccolingual Inclination

1

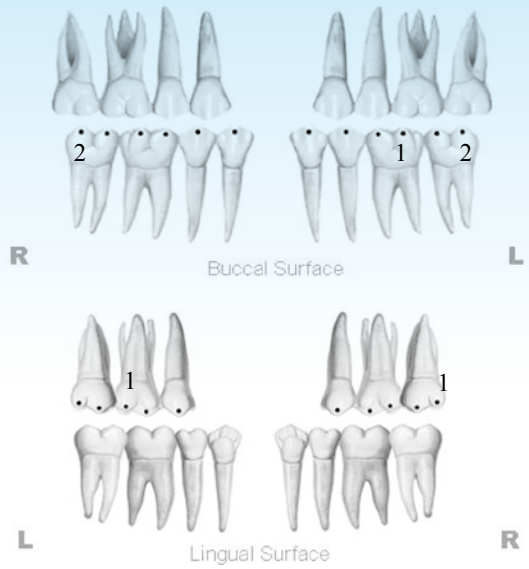


Overjet

1

Occlusal Contacts

7

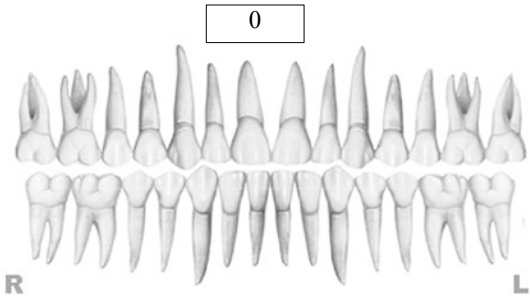


Occlusal Relationships

2

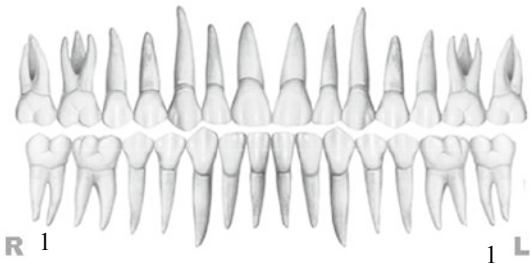
Interproximal Contacts

0



Root Angulation

2



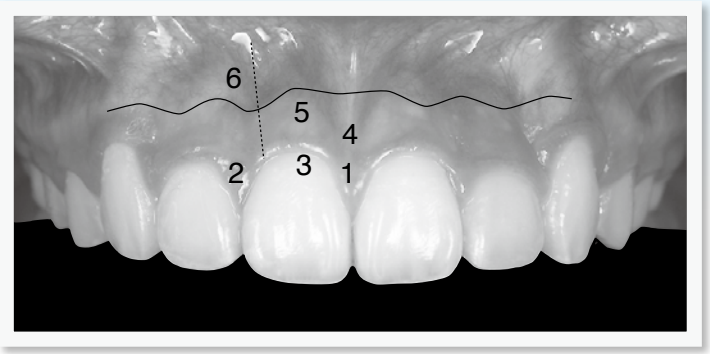
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 3

1. Pink Esthetic Score

Total = 0

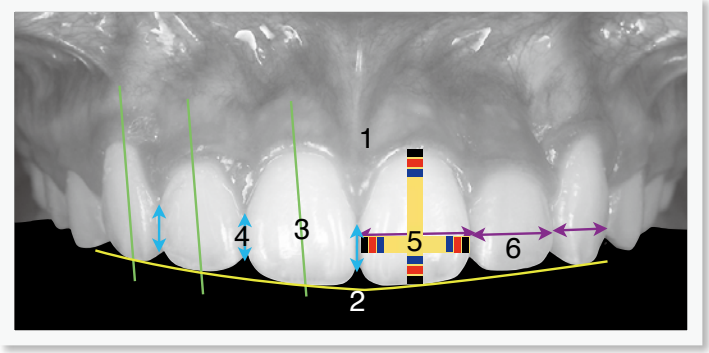


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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

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* TADs made of Ti alloy have a lower failure rate compared to SS when placed in thin cortical bone. These results are consistent with a biocompatibility-related tendency for less bone resorption at the bone screw interface.
Reference: Failure Rates for SS and Ti-Alloy Incisal Anchorage Screws: Single-Center, Double-Blind, Randomized Clinical Trial (J Digital Orthod 2018;52:70-79)

** The overall success rate of 93.7% indicates that both SS and TiA are clinically acceptable for I2C BSs.
Reference: Failure rates for stainless steel versus titanium alloy infrazygomatic crest bone screws: A single-center, randomized double-blind clinical trial (Angle Orthod 2019;89(1):40-46)

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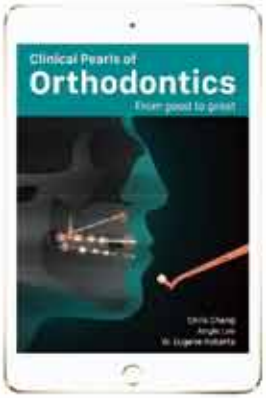

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SmartArch® Multi-Force, Super-Elastic Archwires: A New Paradigm in Orthodontics

Abstract

SmartArch® (S-A) archwires are laser-conditioned CuNiTi wires with a differential force profile that is based on the optimal compressive stress in the periodontal ligament (PDL) to achieve rapid tooth movement with minimal necrosis. Compared to alignment with a progression of two CuNiTi archwires (0.016 and 0.018-in), a single 0.016-in S-A is significantly ($p<0.02$) more efficient in correcting interproximal discrepancies, decreasing deepbite, and leveling the Curve of Spee. Failure to bond and align lower second molars results in marginal ridge discrepancies of up to 3mm that substantially delay treatment. Beta testing of initial alignment with a 3mo each sequence of 0.016-in and 0.017x0.025-in S-A archwires in a 0.018-in slot Ti Orthos® brackets revealed that simultaneous leveling and aligning of deepbite malocclusions was achieved in ~6mo. Three of the 10 moderate malocclusions treated were finished to <26 points on a cast alignment evaluation (CAE). These optimal results broadened the focus of clinical investigation to address an important limitation of indeterminate mechanics in orthodontics: excessive treatment time due to the repetitive PDL necrosis, associated with frequent reactivations. The new paradigm in orthodontics is an emphasis on precise bracket positioning to enable simultaneous 3D alignment of both arches with the 2-Step S-A sequence. Intermaxillary mechanics (Class II/III) should be avoided until the arches are aligned, and finishing TMA or SS archwires are in place. Then utilize determinate mechanics by applying elastics to archwire lugs mesial to the canines for the correction of midlines and buccal interdigitation. Detailing bends (only if required) should be the last stage in mechanics before debonding. 2-Step S-A 3D alignment, in the context of precise bracket positioning and determinate major mechanics, is expected to decrease chair-time, improve outcomes, and decrease treatment time at least 50%. (J Digital Orthod 2019;55:66-79)

Key words:

Indeterminate and determinate mechanics, CuNiTi, accelerated treatment, decreased treatment deration, multiforce, superelastic, multiple memory technology, ideal physiologic load, martensite-austenite transition, interbracket distance

Introduction

SmartArch® (*S-A*) is a new generation of multi-force archwire (*MFAW*) that has differential superelastic properties based on advanced concepts in materials science, and periodontal ligament (*PDL*) physiology. Shape memory alloys (*SMAs*) are materials that are resistant to permanent deformation (*wire bending*). They usually have a lower modulus of elasticity, compared to stainless steel (*SS*) and titanium molybdenum alloy (*TMA*) (*Fig. 1A*).[1] Heat treatment adjusts the memory of SMAs such as copper nickel titanium (*CuNiTi*) to deliver different levels of superelastic force (*Fig. 1B*). The transformation factor is the level of stress-related deflection required to activate the martensite-austenite transition (*Fig. 2*). This important material property can be programmed with: 1. furnace heating, holding and cooling, 2. pulsed electric current with a Memory-

Dr. W. Eugene Roberts,
Indianapolis, Indiana (Left)
Dr. Jeffery A. Roberts,
Indianapolis, Indiana (Center left)
Dr. Stephen Tracey,
Upland, California (deceased) (Center right)
Dr. David M. Sarver,
Vestavia Hills, Alabama (Right)

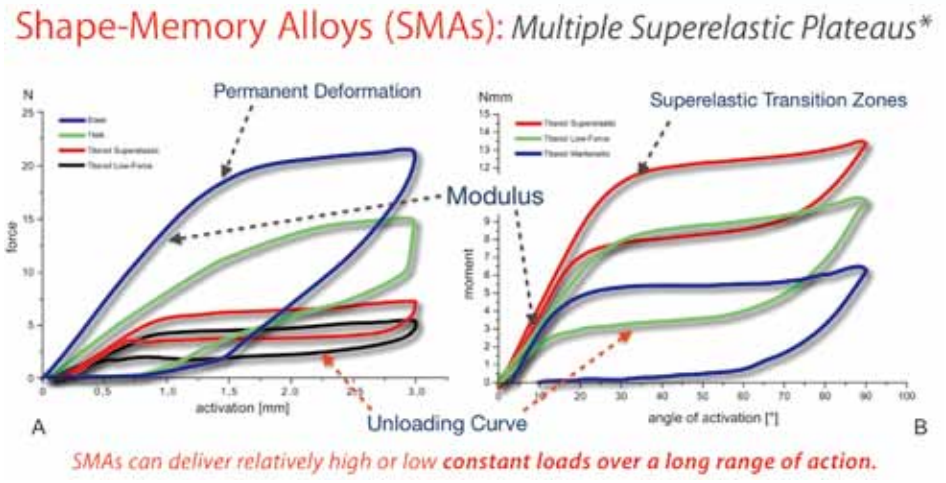

Fig. 1:

A. *Shape memory alloys have a uniform initial modulus of elasticity and are resistant to permanent deformation. When loaded into the superelastic range, the unloading curve is relatively uniform for a given plateau of force. Titanol is a trademark for Forestadent (Pforzheim, Germany). See text for details.*

B. *Modification of the superelastic transition zone with heat treatment produces unloading curves with variable levels of unloading force. These illustrations are modified versions from an original article published by the senior author (WER).*[1]

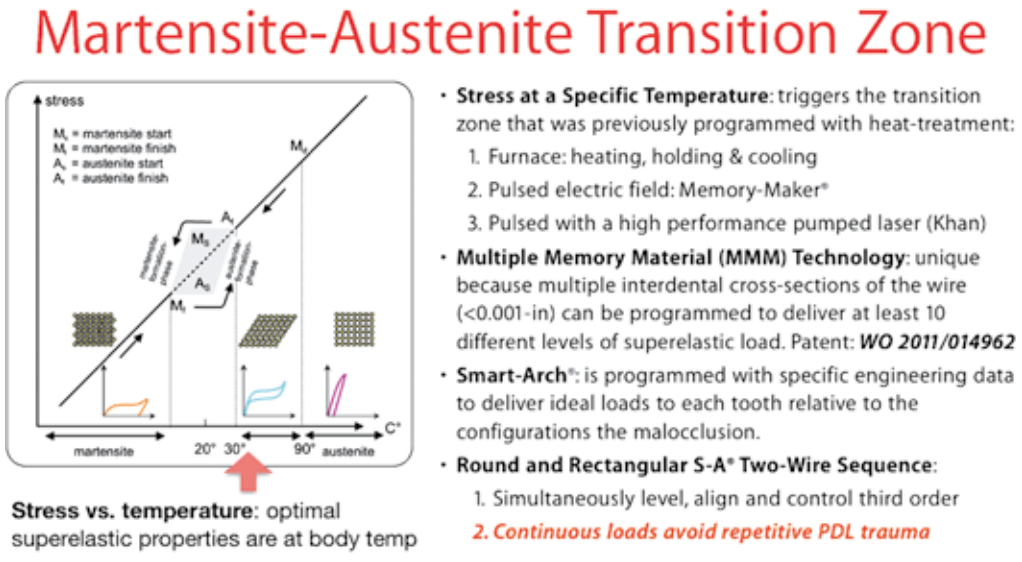

Fig. 2:

The level of stress (wire deformation) to enter the martensite-austenite transition zone is adjusted with heat treatment. This is a copy of a presentation slide explaining the concept relative to Md arch alignment in 3D. This illustration is a modification from an original article published by the senior author (WER).[1]

Maker® (*Forestadent, Pforzheim, Germany*),[1] or 3. pulsed fiber laser conditioning (*Smarter Alloys™, Waterloo ONT Canada*).[2] The latter method is the patented multiple memory material (*MMM*) concept (*Fig. 3*). MMM technology can precisely program transition zones as narrow as 0.001-in in a cross-section of SMA wire. At least 10 levels of superelastic unloading profiles can be programmed into a single CuNiTi archwire (*Fig. 4*). S-A is manufactured according to specific PDL compressive stress values, derived from finite element analysis (*FEA*) of digital dental templates exposed to four types of tooth movement (*Fig. 5*).[4] The S-A archwires currently on the market (*Ormco, Brea CA*) are made for the average human dentition. However, with cone-beam computed tomography (*CBCT*) data, S-A archwires can be custom manufactured for specific arches and patients.

Orthodontics is accomplished with both determinate and indeterminate mechanics.[5-10] The determinate approach is more predictable because all the 3D forces and moments are known. However, there must be no more than two abutments: teeth, arches or segments.[5,7,9,10] Any device (*archwires or aligners*) engaging multiple teeth at once is statically indeterminate. Loads are transferred throughout the periodontium in an unknown manner,[5,6] resulting in PDL necrosis that delays tooth movement and induces root resorption every time the mechanics are reactivated.[5,6,11] The ideal physiologic force for each tooth is based on interbracket distance, and the

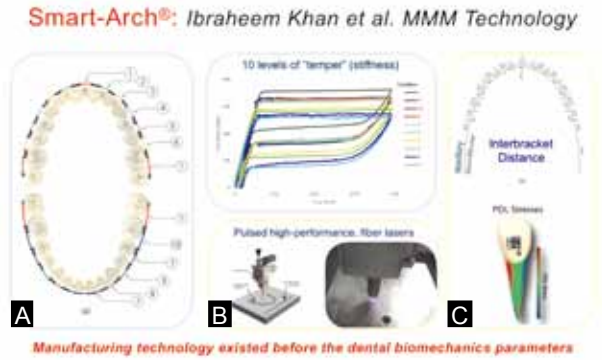

Fig. 4:
A presentation slide illustrates the MMM technology developed by Ibraheem Khan et al.[2,3] to produce Smart-Arch® archwires. Variable interbracket distances are shown on the left (A). The lower right illustration depicts mechanical stress in the PDL (C). These critical PDL physiologic parameters were unknown when the manufacturing technology was developed. See text for details.

Fig. 3:
Smart-Arch® technology and its clinical applications are summarized in a presentation slide.

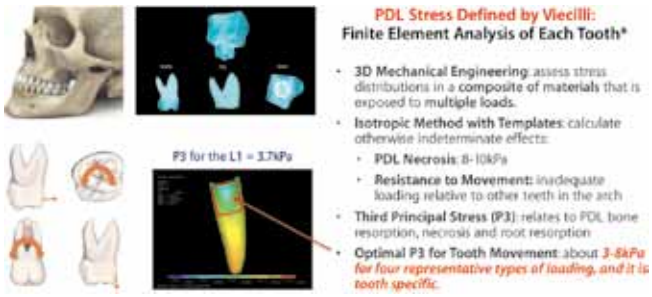

Fig. 5:
PDL stress was defined by Rodrigo Viecilli[4,11] with FEA for each tooth in the mouth except third molars. The optimal archwire force for four types of tooth movement was calculated to produce adequate PDL stress to move a tooth without inducing necrosis. See text for details.

average PDL compressive stress (*P3*) calculated with FEA for four types of tooth movement (*Figs. 5 and 6*).[4] The S-A force profile is based on ideal physiologic loads, which are not achieved with common initial alignment archwires such as 0.014-in CuNiTi, and the previous generation of MFAW (*Tri-Force™, G&H Orthodontics, Franklin IN or similar*), a GAC-Dentsply (*Harrisburg PA*) product that is now out of patent. Figure 7 illustrates the relative force levels per tooth in a panoramic view of the maxillary arch. The inset on the upper right (*blue background*) shows a color-coded view of the superelastic levels programmed into the interbracket segments of a maxillary S-A archwire (*Fig. 7*).

S-A archwires are a unique concept in orthodontic mechanics (*Fig. 8*). They deliver physiologically optimized loads for an extended period of time. This advance in orthodontic materials helps control the indeterminate mechanics, and repetitive archwire reactivations that lengthen treatment and compromise outcomes. It is hypothesized that S-A 0.016-in round, and 0.018x0.025-in (*0.022-in slot*) or 0.017x0.025-in (*0.018-in slot*) rectangular archwires are efficient for initial alignment and leveling without presenting any unusual risks to the patients.

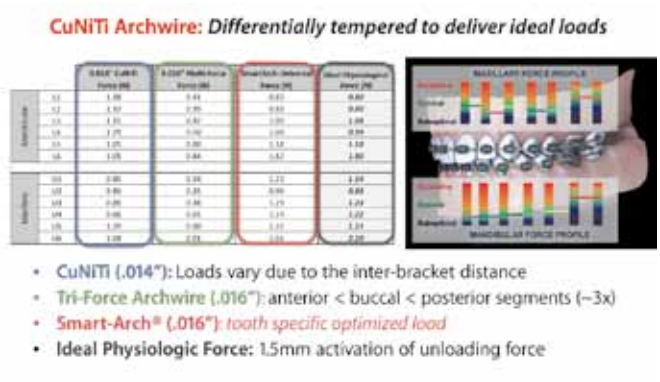

Fig. 6:
S-A is a modified CuNiTi archwire that was differentially tempered to deliver the ideal physiologic load for each tooth, as previously calculated by Viecilli (Fig. 5). Neither 0.014-in CuNiTi nor a 0.016-in Tri-Force™ archwires comply. See text for details.

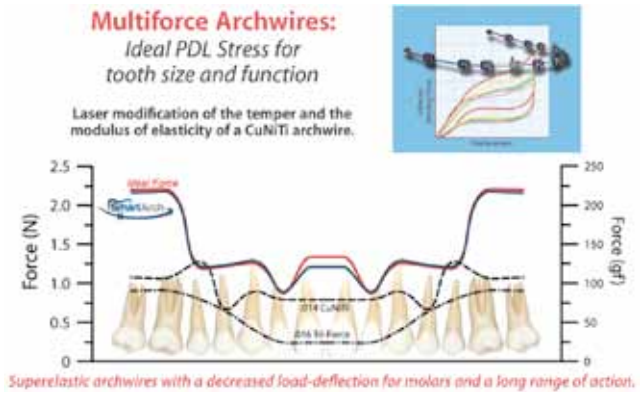

Fig. 7:
Three types of initial archwires are illustrated. 0.014-in CuNiTi is a uniform material that delivers variable force depending on interbracket distance. Tri-Force™ is a first generation MFAW that produces progressively increasing force from the canine to the second molar. S-A is programmed to fit the ideal force curve derived by Viecilli (Fig. 5). The color-coded drawing on the upper right shows multiple superelastic force levels programmed into the interproximal segments of a maxillary S-A archwire.

Fig. 8:
Smart-Arch® is a unique archwire concept that is available in a 0.016-in round and 0.018x0.025-in rectangular configurations. The 2-Step 3D alignment procedure utilizes each wire for 3mo to resolve a Class I malocclusion. Class II or III problems are corrected with determinate mechanics by applying elastics to lugs on the archwires mesial to the canines. See text for details.

Materials and Methods

All clinical records were retrospectively sourced from private practices with an industrial Institutional Review Board (*IRB*) approval: Solutions IRB.com, Protocol #2019/01/18.

- **Inclusion** criteria: 1. routine malocclusions requiring full fixed appliances in both arches, 2. late mixed or permanent dentition, 3. initial alignment accomplished with a S-A archwire, and 4. no additional mechanics such as bracket repositioning or intermaxillary elastics.

- **Exclusion** criteria: 1. craniofacial anomalies, 2. missing more than four permanent teeth, 3. periodontal compromise, and 4. treatment involving orthognathic surgery. With the patient' s permission (*and parent if a minor*), deidentified casts and intraoral photographs (*start and finish*) were sourced along with intraoral photographs at variable intervals when the patients were seen during the initial alignment process.

Study 1. The lower arch was initially aligned with a single 0.016-in S-A archwire in 0.022-in slot Damon Q® brackets (*Ormco, Brea CA*). Two of the authors, JAR (*Indiana*) and ST (*California*) submitted deidentified casts and intraoral photographs for 7 and 6 patients, respectively. The collective treatment times were 128.5±34.2 (*range 72-190*) days. S-A archwires were removed when sufficient alignment was achieved to progress to the next archwire. There were no casts, so all measurements were made on intraoral photographs and thermoplastic bite registrations (*Heat & Bite®, Ormco, Brea CA*).

Study 2. Treatment was identical to Study 1 except the brackets were 0.018-in Ti Orthos® (*Ormco, Brea CA*), and both arches were aligned with 0.016-in S-A. The treatment times were 143.0±34.1 (*range 60-180*) days. The retrospective clinical records were casts and intraoral photographs at the start and finish, as well as intraoral photographs when progress was evaluated.

Study 3. Treatment and records sourced were identical to Study 2 except the initial alignment sequence was 0.016-in CuNiTi for 3mo followed by 0.018-in CuNiTi for 3mo, and the treatment time was uniform for all patients (*~180 days*). Progress photographs and thermoplastic bite registrations were collected at varying intervals when patients presented for evaluation. This was an independent study conducted by two of the authors (*WER, DMS*), and submitted for publication.[6] It was not supported or controlled by any commercial interests.

Study 4. Ti Orthos® brackets (*0.018-in slot*) were bonded on both arches of 10 consecutive, routine malocclusions. Initial leveling and alignment in 3D was accomplished with 0.016-in S-A for 3mo followed by a 0.017x0.025-in S-A for 3mo. A casts-only discrepancy index (*C-O DI*) was performed at the start of treatment. The method is identical to the American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) except there is no radiographic analysis (*cephalometrics*).[6] Cast Alignment Evaluations (*CAE*) were performed at the end of each stage of the alignment phase. The CAE is similar to the ABO cast-radiograph evaluation (*CRE*) except it is a casts-only method with no evaluation of a panoramic radiographs.[6]

Records Assessment: The interproximal discrepancy index (*IDI*) was the total malalignment for all marginal ridge discrepancies (*MRDs*). MRDs between mandibular first (*L6*) and second (*L7*) molars were deemed 7-6 discrepancies. They were measured separately on the casts and then summed to simplify the data presentation. In brief, the alignment of all erupted teeth was assessed in 3D on casts, and in 2D on photographs. Measurements were made under high intensity light at 2x magnification (*Opti-Visor™ head-band loupes, Donegan Optical, Lenexa KS*) to the nearest 0.5mm with an analog precision caliper (*Mitutoyo, No. 505-633-50, Kanagawa, Japan*), which has a resolution of 0.05mm. Overbite and overjet were measured to the nearest 0.1mm at the start and end of the study with the same caliper.[6] Overjet, overbite and curve of Spee (*CoS*) measurements were made on start and finish casts for Studies 2 and 3. Data were summarized with means and standard deviations. Statistical significance was tested with the paired two-tailed t-test programmed into Microsoft Excel (*Redlands, WA*).

Results

Two patients, one in Study 1 and another in Study 2, experienced fractures of 0.016-in S-A archwires in the lower posterior segments in the same area: between the second premolars and the first molars. The problems were asymptomatic, and the fractured archwires were replaced within 7d. There were no problems with any of the rectangular S-A wires. The hypothesis is accepted that S-A archwires, in the 0.016-in, 0.017x0.025-in, and 0.018x0.025-in configurations, provide efficient continuous loads for initial alignment. None of the archwires presented any unusual risks to patients.

MFAW is the generic term for archwires that deliver variable loads. Smart-Arch® (*S-A*) is a second generation MFAW that delivers differential loads to individual teeth based on physiologically relevant PDL stress levels.[4] The only uniform aspect of the beta testing across groups was initial alignment of the mandibular arch with 0.016-in S-A. Those comparative data are presented for studies 1-3 in Table I, and statistical tests are summarized in Table II. The IDI was significantly ($p<0.001$) reduced for all groups at 128-180d, as specified (*Fig. 9; Tables I and II*). There was no difference for the final IDI between groups, except for studies 3 vs. 1 ($p<0.001$). A 3mo each sequence for 0.016 and 0.018-in CuNiTi wires in 0.018-in Ti Orthos® brackets provided a baseline reference for routine initial alignment.[6] The IDI was reduced from 11.3±4.2 to 3.9±2.5mm, which is a 61.4±26.6% correction in a standardized 6mo period (*180d*). A 0.016-in S-A archwire in same Ti Orthos® brackets was more effective ($p<0.03$) than CuNiTI in reducing the IDI from 15.8±6.5 to 2.5 ±2.7mm, which was a 82.2±19.5% correction in 143.0±35.3d. The same S-A archwire in a 0.022-in Damon Q® bracket was even more effective ($p<0.01$) for reducing the initial IDI for severe malocclusions from 21.4±6.4 to 1.1±1.2mm, which was a 94.5± 6.2% correction in 128.5±34.2d (*Fig. 9*). The time course for initial alignment (*Study 2*) was compared for the maxillary (*Mx*) and mandibular (*Md*) arches by separating the progress (*124±34d*) from the finish (*180d*) data. There were no significant differences in IDI or percent correction data between the divided

Lower Arch Alignment: Correction of the Interproximal Discrepancy Index (IDI)

	Study 1. S-A 0.022-in Damon Q			
	Initial IDI	Final IDI	% Correction	Tx Time d
	31.1	1	97.0%	141
	15.5	2	87.0%	141
	11	0	100.0%	119
	28	0.5	98.0%	141
	23	0	100.0%	179
	13	0	100.0%	190
	26	1	96.0%	72
	20.5	4	80.0%	92
	27	1	96.0%	141
	16	1	94.0%	119
	17	2	88.0%	112
	23	0	100.0%	84
	27	2	93.0%	139
Mean	21.4	1.1	94.5%	128.5
SD	6.4	1.2	6.2%	34.2
n	13			

	Study 2. S-A 0.018-in Ti Orthos			
	Initial IDI	Final IDI	% Correction	Tx Days
	19.2	3.3	82.8%	180
	13.7	8.3	39.4%	180
	11.2	5.8	48.2%	180
	6.5	1	84.6%	180
	18.2	7	61.5%	180
	6.2	2	67.7%	120
	26.4	3.2	87.9%	150
	17.6	0	100.0%	105
	4.4	0	100.0%	120
	22.2	2	91.0%	120
	18.2	3.5	80.8%	120
	13.4	1	92.5%	150
	16.4	0.5	97.0%	150
	19.6	0	100.0%	150
	23.2	0	100.0%	60
Mean	15.8	2.5	82.2%	143.0
SD	6.5	2.7	19.5%	35.3
n	15			

	Study 3. CuNiTi 0.018-in Ti Orthos			
	Initial IDI	Final IDI	% Correction	Tx days
	8.5	7.5	11.8%	180
	9.5	2	78.9%	180
	14.9	8	46.3%	180
	17.2	3.5	79.7%	180
	10.2	0	100.0%	180
	5	3	40.0%	180
	10.5	8	23.8%	180
	13.5	4.5	66.7%	180
	17	2	88.2%	180
	12	4.5	62.5%	180
	10	2	80.0%	180
	11	4	63.6%	180
	13.5	1.5	88.9%	180
	9.5	5.5	42.1%	180
	15.5	6	61.3%	180
	10	2	80.0%	180
	14	7	50.0%	180
	2.5	2.5	0.0%	180
	5	0.5	90.0%	180
	17.5	4.5	74.3%	180
Mean	11.3	3.9	61.4%	180.0
SD	4.2	2.5	26.6%	0.0
n	20			

Table I:

Correction of interproximal discrepancies in the lower arch with S-A or CuNiTi (3mo 0.016-in - 3mo 0.018-in) in two types of brackets: 0.022-in slot Damon Q®, and 0.018-in Ti Orthos®.

Two-Tailed T-Test for Statistical Significance (p<.05)			
	Initial IDI	Final IDI	% Correction
Study 1		0.001	
Study 2		0.001	
Study 3		0.001	
Study 1 vs 2	0.03	0.10	0.001
Study 2 vs 3	0.02	0.11	0.017
Study 3 vs 1	0.02	0.001	0.001

Table II:

Statistical comparison of Studies 1-3 was with paired t-tests. Compared to the initial IDI, the final IDI was significantly reduced (p<0.001) in all three studies. The S-A Damon Q® group (Study 1) had a significantly greater mean IDI (p<0.03) and were treated to the highest percent correction (P<0.01), compared to the other groups.

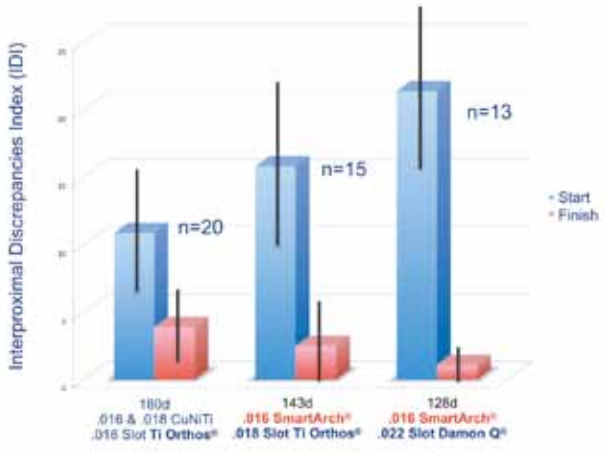

Fig. 9:

Correction of mandibular interproximal discrepancies with 0.016/0.018-in CuNiTi is compared to S-A 0.016-in in Ti Orthos® and Damon Q® brackets. All of the methods produced significant (p<0.001) decreases in the IDI. However, S-A delivered a significantly (p<0.01) better correction for more complex malocclusions in both types of brackets. See text for details.

samples. The IDI decreased to a minimal level of 1.40mm at progress sampling (*124±34d*), but then relapsed to 5.02mm at the prescribed 180d finish (*Fig. 10; Table III*). Leveling was assessed as the correction of deepbite (*overbite*), Curve of Spee (*CoS*), and Md first and second molar (*7-6*) MRDs (*Fig. 11; Tables IV-VI*). Deepbite (*overbite*) of >3mm was prevalent in both the MFAW (*83.3%*) and CuNiTi (*70%*) samples (*Table IV*). Overbite was significantly ($p<0.001$) decreased ~2mm with S-A MFAW, but not with CuNiTi leveling. The initial CoS was ~0.7mm less ($p<0.006$) in CuNiTi compared to S-A MFAW patients (*Table V*). CuNiTi alignment failed to significantly level the lower arch. On the contrary, MFAW (*S-A*) archwires significantly decreased the deepbite ($p<0.008$) and CoS ($p<0.001$). In addition, there was a nonsignificant ($p<0.11$)

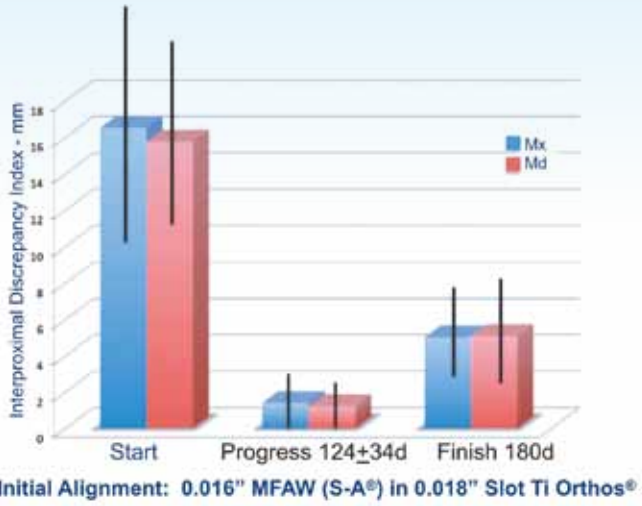

Fig. 10:
Correction of interproximal discrepancies in the maxillary (Mx) and mandibular (Md) arches is shown at the start, progress and finish (180d). Note that most patients reach an optimal correction by about 90d and then relapse. See text for details.

6mo Initial Alignment: MFAW (.016" S-A) in.018" Ti OrthosBrackets

	Upper Arch			Lower Arch			
	Initial IDI	Final IDI	% Correction	Initial IDI	Final IDI	% Correction	Tx Time d
	19.7	9	54.3%	19.2	3.3	82.8%	180
	9.6	5	47.9%	13.7	8.3	39.4%	180.0
	13.2	4.5	65.9%	11.2	5.8	48.2%	180
	11.8	1.6	86.4%	6.5	1	84.6%	180
	24	5	79.2%	18.2	7	61.5%	180
	20	3	85.0%	6.2	2	67.7%	120
	18.6	3	83.9%	26.4	3.2	87.9%	150
	8	0	100.0%	17.6	0	100.0%	105
	7.5	1	86.7%	4.4	0	100.0%	120
	19.3	2	89.6%	22.2	2	91.0%	120
	39.8	4	89.9%	18.2	3.5	80.8%	120
	13.5	0	100.0%	13.4	1	92.5%	150
	12	1	91.7%	16.4	0.5	97.0%	150
	19.9	0	100.0%	19.6	0	100.0%	150
	11.1	0	100.0%	23.2	0	100.0%	60
Means	**16.53**	**2.61**	**0.84**	**15.76**	**2.51**	**0.82**	**143.00**
SD	7.91	2.48	15.7%	6.27	2.59	18.9%	34.1
n=15	15	15	15	15	15	15	15
p<		0.001			0.001		
p<	Upper Arch vs. Lower Arch			0.74	0.84	0.58	

	Upper Arch			Lower Arch			
	Initial IDI	Final IDI	% Correction	Initial IDI	Final IDI	% Correction	Tx Time d
≤150d	20	3	85.0%	6.2	2	67.7%	120
	18.6	3.0	83.9%	26.4	3.2	87.9%	150.0
	8	0	100.0%	17.6	0	100.0%	105
	7.5	1	86.7%	4.4	0	100.0%	120
	19.3	2	89.6%	22.2	2	91.0%	120
	39.8	4	89.9%	18.2	3.5	80.8%	120
	13.5	0	100.0%	13.4	1	92.5%	150
	12	1	91.7%	16.4	0.5	97.0%	150
	19.9	0	100.0%	19.6	0	100.0%	150
n=10	11.1	0	100.0%	23.2	0	100.0%	60
Means	**16.97**	**1.40**	**92.7%**	**16.76**	**1.22**	**91.7%**	**124.50**
SD	9.36	1.51	6.7%	7.08	1.37	10.6%	28.33
p<	Upper Arch vs. Lower Arch			0.95	0.37	0.72	
180d	19.7	9	54.3%	19.2	3.3	82.8%	180
	9.6	5	47.9%	13.7	8.3	39.4%	180
	13.2	4.5	65.9%	11.2	5.8	48.2%	180
	11.8	1.6	86.4%	6.5	1	84.6%	180
n=5	24	5	79.2%	18.2	7	61.5%	180
Means	**15.66**	**5.02**	**66.7%**	**13.76**	**5.08**	**63.3%**	**180**
SD	5.99	2.64	16.2%	5.21	2.93	20.2%	0.00
p<	Upper Arch vs.Lower Arch			0.35	0.97	0.71	

Table III:
Six months of initial alignment data is presented for both arches treated with 0.016-in S-A archwires in 0.018-in slot Ti Orthos® brackets.

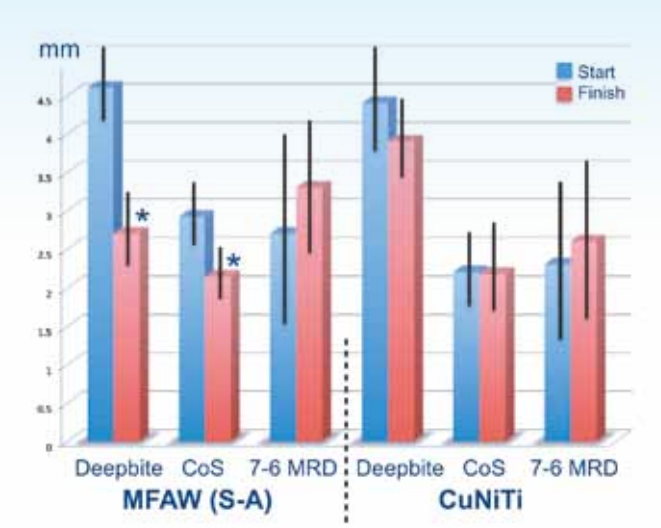

Fig. 11:

During a uniform180d aligning and leveling phase with a 6-6 fixed appliance, MFAW (S-A) archwires were more effective than CuNiTi for decreasing deepbite (p<0.001) and the CoS (p<0.001), but 7-6 MRDs tended to increase (p<0.1 CuNiTi had no significant effect in leveling the arches, but 7-6 MRDs also tended to increase. See text for details.

tendency to increase 7-6 MRDs in the lower arch, which resulted in combined bilateral discrepancies up to 5.5mm (*Table VI*). Three of the CuNiTi patients required posterior bite turbos, but they were not needed for the MFAW (*S-A*) group (*Table V*).

The group of 10 consecutive patients with routine malocclusions (*C-O DI=13.2*) was selected to investigate 2-Step S-A 3D alignment procedure (*Fig. 12*). The demographics for the 10 patients were: age 16.0±14.9yr, 80% female, 90% Caucasian, 80% moderate Class II, 30% excessive overjet, 90% deepbite (*>3mm*), and 70% with at least 5mm of crowding. After 3mo of 0.016-in S-A archwire treatment, dental alignment was improved to a CAE of 41.0 points. Following 3mo of 0.017x0.025-in S-A third order alignment, the CAE decreased to

MFAW (S-A) 0.016-in 6mo Initial Alignment				CuNiTi 0.016-in 3mo, 0.018-in 3mo		
Deepbite of at least 3mm: 15/18 (83.3%)				Deepbite of at least 3mm: 14/20 (70.0%)		
Overbite	Start	Finish	Change	Start	Finish	Change
	5	3	2	5.9	5.5	0.4
	5	2.5	2.5	8.5	7	1.5
	3.5	2	1.5	4.6	3.5	1.1
	3	2	1	5	4.5	0.5
	6	3.5	2.5	3.6	4	-0.4
	4.8	1.5	3.3	3.7	3.5	0.2
	5	3.5	1.5	3.7	2.5	1.2
	4.4	2.8	1.6	4.2	2.5	1.7
	4.1	3.3	0.8	3.5	3.5	0
	4.3	2	2.3	4	3.5	0.5
	4.4	3.5	0.9	3.4	4	-0.6
	5.7	3.5	2.2	4	3.5	0.5
	4.2	2.3	1.9	4.5	4.5	0
	5.8	4	1.8	3	2	1
	4.5	1.4	3.1			
Mean	4.6	2.7	1.9	4.4	3.9	0.5
SD	0.82	0.82	0.82	1.39	1.28	0.69
Turbos	None			3 (Shaded)		
n	15			14		
p<		0.001			0.292	
p<	Two-tailed t-test: MFAW vs. CuNiTi			0.563	0.008	0.001

Table IV:

Six months of initial alignment data is presented for both arches treated with 0.016-in S-A archwires in 0.018-in slot Ti Orthos® brackets.

MFAW (S-A) 0.016-in Initial Align 6-6				CuNiTi 0.016-in 3mo, 0.018-in 3mo		
Curve of Spee						
	Initial	Finish	Change	Initial	Finish	Change
	3.5	2	1.5	1.5	1	0.5
	2.5	1.5	1	1.5	1.5	0
	3.5	1	2.5	3	4	-1
	3.5	2	1.5	2.5	3	-0.5
	3	2	1	2	2	0
	3	2.5	0.5	3	2	1
	2.5	2.5	0	2	3	-1
	3.5	2.5	1	1.5	3	-1.5
	4	3	1	3	3	0
	2.5	1.5	1	3.5	3	0.5
	3	2.5	0.5	3	1	2
	2.5	2.5	0	3.5	0.5	3
	3	2	1	1	1	0
	4	3.5	0.5	1	0	1
	2	2	0	1	1	0
	2.5	2	0.5	2.5	3	-0.5
	2	2	0	1.5	2.5	-1
	2	1.5	0.5	2	4	-2
				3	3	0
				2	2	0
Mean	2.92	2.14	0.78	2.2	2.175	0.025
SD	0.65	0.59	0.65	0.83	1.15	1.12
Turbos	None			3 (Shaded Dark Gray)		
n	18	18	18	20	20	20
p<		0.001			0.92	
p<	MFAW vs. CuNiTi			0.006	0.905	0.020

Table V:

During initial alignment, there was a small decrease (0.78mm) in the curve of Spee (CoS) with MFAW (S-A) that was statistically significant (p<0.001), but there was no significant change in CoS with CuNiTi.

Summed 7-6 Marginal Ridge Discrepancies: Initial Alignment 6-6						
	MFAW 0.016-in Initial Alignment 6-6			CuNiTi 0.016-in 3mo, 0.018-in 3mo		
	Initial	Finish	Change	Initial	Finish	Change
	0	3	3	1	0	1
	2.5	5.5	3	3.2	0	3.2
	5.3	4	-1.3	3.7	0	3.7
	4	5	1	2.5	0	2.5
	5.2	5.5	0.3	3	0	3
	4.5	5	0.5	2.5	0	2.5
	3	3.5	0.5	0.5	0	0.5
	2.5	3	0.5	4	0	4
	4	3	-1	1	0	1
	2	2	0	3	0	3
	1	2	1	1.5	0	1.5
	0	1	1	2	0	2
	1.5	1	-0.5	3.7	0	3.7
				0.5	0	0.5
Mean	2.7	3.3	0.6	2.3	0.0	2.3
SD	1.8	1.6	1.3	1.2	0.0	1.2
n	13	13	13	14	14	14
P<		0.11			0.00	
P<	MFAW vs. CuNiTi			0.46	0.00	0.00

Table VI:

The summed lower 7-6 marginal ridge discrepancies tended to increase in both the MFAW (S-A) and CuNiTi groups. The mean change was greater but not significant (p<0.1 for S-A. However, the value of the data is to demonstrate that alignment of lower 6-6 when the 7s are present is inefficient and extends treatment time.

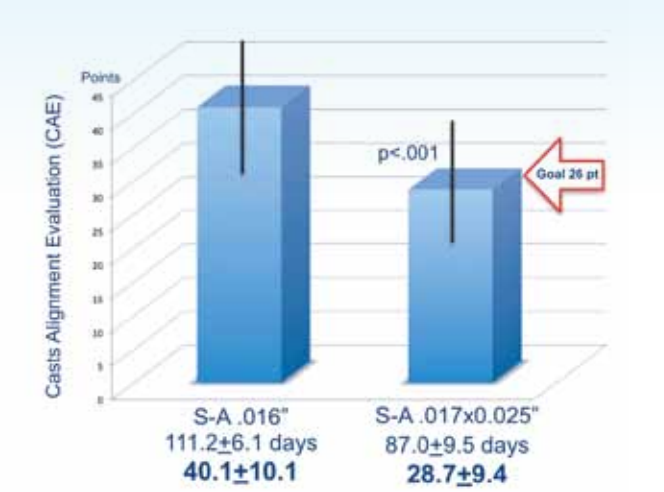

Fig. 12:

The 2-Step 3D alignment procedure was performed on 10 patients with routine malocclusions (C-O DI of 13.2). After 3mo of alignment with 0.016-in S-A, a CAE scored residual discrepancies at a mean of 41 points. A subsequent 3mo of 0.017x0.025-in S-A correction resulted in a mean CAE of 28.7. After 6mo of 3D alignment, near optimal alignment was achieved (Goal of 26 points). See text for details.

28.7 points (*P<0.001*) (*Fig. 12*). The predefined goal of 26 points for a well aligned dentition (*"board-quality result"*) was achieved by three of the patients (*shaded gray in Table VII*).

Discussion

Aligning and leveling the arches of deepbite patients, without excessive bite opening, is a common problem because overbite of 3mm or more is prevalent (*70-90% of the samples*) (*Tables IV and VII*).[6] Managing a deepbite and excessive CoS in the lower arch is one of the most challenging and time consuming aspects of orthodontics therapy, because conflicting archwire properties are required. Highly flexible, low force archwires such as CuNiTi are the most effective for correcting rotations and crowding (*Fig. 9*), but they lack the posterior rigidity to effectively level the arch (*Fig 11*).[6] At least four and sometimes six CuNiTi and stainless steel (*SS*) archwires are required to align and level deepbite patients with an excessive CoS.[12]

Posterior bite turbos are commonly used during initial alignment to alleviate bracket interference (*Table V*). Bonding glass isomer cement on the occlusal surface of lower first molars is the most common approach. This short-term solution for bracket interference presents a risk of posterior openbite and/or incisal trauma, when the bite turbos are removed. No bite turbos were required for initial alignment with 0.016-in S-A Ti Orthos®

Smart-Arch 2-Step 3D Alignment in 6mo									Days		Days	Goal 26
	Age (yr)	Sex	Ethnic	Class II	OJ	OB	Crowding	C-O DI	0.016	CAE 1	17x25	CAE 2
	12.5	F	C	I		DB		16	111	38	90	28
	11	F	C	II		DB	Yes	6	121	43	90	35
	59	M	C	II				16	112	48	90	32
	11.8	F	C	II		DB	Yes	16	104	43	90	34
	12.5	F	AA	I		DB	Yes	5	106	44	90	19
	11	F	C	II		DB	Yes	17	119	48	90	27
	12.5	F	C	I/II	OJ	DB		10	107	55	90	48
	11.3	M	C	II	OJ	DB	Yes	14	106	26	90	23
	12.1	F	C	II	OJ	DB	Yes	16	108	43	90	27
	12.5	F	C	II		DB	Yes	16	118	22	60	14
n	10	80% F	90% C	80%	30%	90%	70%					30%
Mean	16.0							13.2	111.2	41.0	87.0	28.7
SD	14.9							4.5	6.1	10.1	9.5	9.4
								CAE 1 vs CAE 2			p<	0.0003

■ *Table VII:*

The 6mo S-A 2-Step 3D alignment procedure was evaluated in 10 consecutive, routine patients. The initial malocclusion was assessed with the casts-only discrepancy index (C-O DI) and alignment was measured with the cast alignment evaluation (CRE). Three patients (30%, shaded in gray) achieved the alignment goal of <26 points in <200d. Sex was designated as male (M) or female (F). Ethnic group was white Caucasian (C) or African American (AA). Patients with a deep overbite (OB) were classified as deepbite (DB). CAE is cast alignment evaluation. See text for details.

brackets (*Table V*). This favorable result is explained by the resistance of low profile titanium brackets to bonding failures,[13] and the efficiency of S-A to open the bite by decreasing the CoS (*Fig. 11; Table V*). In addition, S-A leveling of the upper arch of a deepbite patient (*Table III*) intrudes and flares the maxillary incisors. Collectively, the stiffer buccal segments of upper and lower S-A archwires help to alleviate lower anterior bracket interference. Avoiding or only using posterior bite turbos for a short period of time considerably simplifies initial alignment and subsequent treatment of deepbite patients (*Figs. 9-11; Tables III-V*). If L7s are erupted, it is important to bond brackets and include them in the initial alignment and leveling process to avoid substantial 7-6 MRDs (*Table VI*). Using flexible, followed by stiff archwires, to correct 7-6 discrepancies delays treatment. Also, the deepbite correction may tend to relapse with transient use of flexible wires, and that problem considerably extends treatment time. It is clear that S-A archwires have considerable potential for enhancing outcomes and decreasing treatment times, but precise bracket positioning from 7-7 is essential.

The timing of archwire use has received little attention. The general rule is that superelastic archwires with a long range of action (*deformation recovery*) can be used in larger dimensions and for longer periods of time,[14] but there is only

one study that has examined the timing for optimal performance of an archwire.[6] Treatment planning for specific archwires is often arbitrary and the performance of a wire is rarely monitored. Simultaneous alignment and leveling with a 0.016-in S-A was expected to require about 6mo (*180d*) because that is the approximate timing with multiple archwires.[14] However, analysis of progress records at a mean of about 124d indicated that optimal correction of interproximal discrepancies was much sooner than 180d (*Fig. 10*). A careful assessment of the progress for individual patients (*Tables I and III*) revealed that optimal resolution of interproximal discrepancies was at 90d or less for many patients. Furthermore, the failure to correct some discrepancies after ~180d was primarily related to incorrect bracket placement. It was concluded that 0.016-in S-A archwires are highly efficient for simultaneous alignment and leveling of both arches, but the optimal treatment time is 3mo (*90d*) and precise bracket positioning is critical.

The same differential load prescription based on FEA (*Fig. 5*) that defined 0.016-in S-A (*Figs. 6 and 7*) was utilized to laser condition rectangular CuNiTi archwires. S-A is now available in 0.017x0.025-in and 0.018x0,025-in for 0.018-in and 0.025-in slot brackets, respectively. The effectiveness for 2-step S-A alignment and leveling in 3D was demonstrated in 10 routine malocclusions using a 3mo round and 3mo rectangular wire protocol (*Study 4*). The brackets were 0.022-in Ti Orthos®, so the 2-step sequence was 0.016-in and 0.017x0.025-in S-A for 3mo each. The average alignment score (*CAE*) after about 198d of treatment was 28.7±9.4 points, which is near the pre-set goal of 26 points. Three of the patients exceeded the goal (*Table VII*). Residual problems for the other 7 patients were incorrect bracket positions and intermaxillary occlusal discrepancies (*Class II or III*). The latter should be corrected with intermaxillary elastics applied to the finishing archwires via lugs mesial to the 3s.[5,7] Applying elastics to teeth particularly in the anterior region is indeterminate mechanics, which risk PDL necrosis because of the play of the wire in the bracket, and the tendency for a tooth to rotate when a force is applied on the buccal surface. In the posterior arch, molar hooks are acceptable because of the large amount of archwire engagement in molar brackets and tubes. If the latter proves to be a problem, elastic lugs can be mounted on the posterior aspects of the archwire.

All of the clinical data currently available from beta testing of S-A archwires indicates there are no unusual risks for patients. Furthermore, these new archwires offer some unique advantages for controlling the alignment and leveling inherent in initial aligning and leveling. The long range of differential action achieves optimal leveling and alignment in about 3mo with each archwire. An increased force to deflection ratio (*stiffness*) in posterior segments, combined with light force and resiliency in the anterior segments, is the combination of material properties that results in simultaneous leveling and aligning in 3D with only two archwires. However, residual discrepancies may not be corrected because of incorrect bracket positions. Contrary to routine clinical practice, it is undesirable to adjust archwires or reposition brackets because that involves additional indeterminate mechanics and PDL necrosis that delays treatment and risks root resorption.[5,8,11] The preferable clinical

approach is is to prevent bracket positioning errors. This may be accomplished with a radiograph-guided indirect set-up. However, the most reliable approach is a computer aided design (*CAD*), and computer aided manufacture (*CAM*) custom appliance based on a digital set-up of the desired final alignment, e.g. Insignia™ (*Ormco Corporation, Brea CA*).

The presently reviewed proprietary research and development to produce and beta test the new S-A archwires is now adequate to define clinical protocols for independent testing of the 6mo - 2-step S-A dental alignment procedure. The senior author (*WER*) and four experienced clinicians have committed to evaluating this promising procedure at their own expense. Supplies and services will be purchased from Ormco (*Brea, CA*), and the patients will pay for their treatment, but the investigators will accept no support nor advice from any commercial interests. The records will be retrospectively sampled with IRB approval and patient permission. The results can be submitted for publication in the refereed orthodontic literature with no conflict of interest.

A baseline (*control*) study of initial alignment with 0.016 and 0.018-in CiNiTi archwires (*3mo each*) in 0.018-in Ti Orthos® brackets is completed and recently submitted for publication.[6] Under identical clinical conditions, a follow-up study utilizing an indirect set-up for positioning the brackets is underway to test the 6mo 2-step S-A 3D initial alignment procedure. Three additional clinicians will use Insignia® for custom appliances to test the 2-step S-A alignment method with three additional types of brackets: Damon Q®, Insignia SL™ (*self-ligating*), and Insignia Twin™. The Damon Q® appliance is an indirect set-up based on a CAD set-up of the final occlusion. The Insignia™ SL and Twin brackets are custom CAM brackets that have milled bases. S-A archwires are available in standard and broad archforms. They can be used with any bracket type depending the clinical objectives for a particular patient. The overall hypothesis for the new paradigm in orthodontics is that 3D alignment with S-A, followed by determinate intermaxillary mechanics will enhance outcomes, decrease treatment time, and help control risks.

Acknowledgment and Disclosures

Studies 1, 2 and 4 were beta testing evaluations of the 0.016-in and 0.017x0.025-in Smart-Arch® archwires supplied by Smarter Alloys™ (*Waterloo, ONT, Canada*). The clinical testing was supported by the Ormco Corporation (*Brea, CA*). Study 3 is an independent clinical evaluation conducted by two of the authors (*WER, DMS*) which is currently submitted for publication.[6] The authors wish to thank Smarter Alloys™ for the graphics downloaded from their website (*Figs. 4-7*). We wish to thank the following for reviewing and editing the manuscript: Drs. Kelton Stewart, Evan Tsai, Jie Chen, Chris Chang, Sam Alauddin, Naphthali Brezniak, Ibraheem Khan.

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賈伯斯的簡報秘訣與設計要素

由國際知名的牙科講師張慧男醫師主講的一天課程，將以他幽默風趣的演講風格來剖析賈柏斯的美學概念以及演講秘訣，利用實例來說明如何設計出視覺優且知識性豐富的專業演講。

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The Beethoven Team Received the CDABO Case Report of the Year Award — The First Chinese Speaking Team to be Presented with this Award

This year's AAO meeting in particular was personally a highlight, as together with my mentor, Dr. Roberts and Dr. Angle Lee (*who unfortunately was unable to attend*). We were the recipients of the CDABO's Case Report of the Year Award. This is the highest clinical award in our field and being the first Chinese speaking team to be presented with this award is indeed an incredible honor. Thanks to all my team for being a part of such an achievement!

I hope this can be a catalyst for the younger generation of Taiwanese Orthodontists and I sincerely hope that I will be able to attend a future AAO meeting and applaud the next Taiwanese recipient of this kind of award.

The following is the full manuscript of my acceptance speech:

Ladies and gentlemen, colleagues, and friends.

It's an exorbitant privilege to be here today and to receive this award.

Before I start, I have to remember to thank my wife. I can't forget that one again!

Four years ago, when Dr. Rolf Behrents had arranged for me to lecture to the St. Louis doctors, he suggested that I should publish my BS screw approach. I know that all of you well-educated people know that BS stands for buccal shelf! Well, when the Editor-in-Chief of such an illustrious journal suggests something like that, one really should follow that up. Little did I know that it would take us 3 years until we had actually finished it, and if we had known, we probably would never have even started writing this case report!

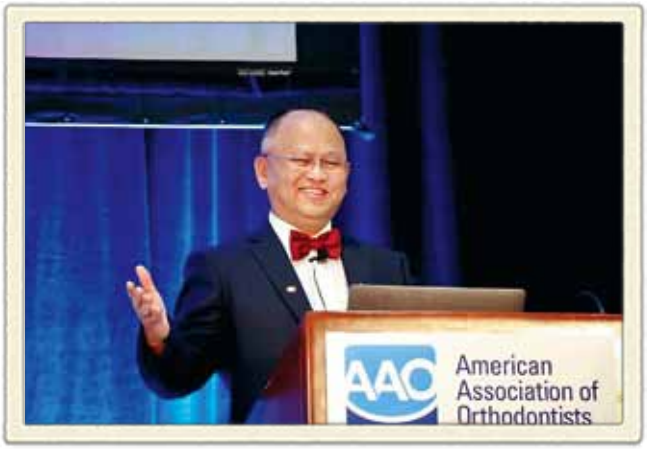

Fig. 1:
Dr. Chris Chang lecturing in the 2019 AAO meeting.

Fig. 2:
Full house for Dr. Chang's lecture at the 2019 AAO meeting.

Furthermore, never did we once expect that it would receive such an award. Our case reports are never written with any intention of receiving an award, but rather to share our experience within our profession, with friends and colleagues. We sincerely hope that everyone can learn from that experience, the good, the bad, and the ugly!

So, firstly, my sincerest thanks to Dr. Rolf Behrents for having set the ball in motion and encouraging me to publish. Also, many thanks to CDABO, for giving me this prestigious award; I will treasure it forever.

Secondly, I have never learned an English word that can express the amount of gratitude, appreciation and respect I have for Dr. Eugene Roberts, who has helped and guided me throughout my career. I can only hope that "Thank you Dr. Roberts" will suffice.

Thirdly, thanks to all of you. We are all each other's teachers as well as students, and I would not be standing here today if it were not for all of you, who have helped to pass on the baton of your experience to me, a member of the younger generation, and I hope that I can help relay the baton to the even younger generation!

Finally, a huge thanks to all my colleagues in the Beethoven Clinic in Taiwan. They do a really fantastic job of documenting all my case reports. Among these colleagues is one individual who has encouraged me to lecture around the world and she is also my on-site speech coach, Ms. Sandra Diver. We couldn't have done it without you. Thank you, Sandra.

And one more thing…just in case she wasn't listening the first time, thanks to my wife, again!

Chris H. Chang PhD, ABO Certified

Active member, Angle Society Midwest
Publisher, Journal of Digital Orthodontics

Fig. 3:
Drs. Eugene Roberts (right) and Chris Chang (center) receiving the AJODO Case Report of the Year Award from Dr. Rolf G. Behrents, AJODO Editor-in-Chief (left) at the 2019 AAO meeting.

Fig. 4:
Dr. Chris Chang holding the Case Report of the Year Award certificate in front of the AAO logo at the 2019 meeting.

張慧男醫師榮獲美國矯正學會期刊最佳案例獎

獲北美地區最大中文報紙-世界日報 World Journal 報導

記者王全秀子/橙縣報導

貝多芬團隊負責人張慧男醫師的臨床案例，月前獲得美國矯正學會期刊（American Journal of Orthodontics and Dentofacial Orthopedics）年度最佳案例。他和共同作者之一，也是張慧男的指導教授 Eugene. W.Roberts 同台領獎。

華人團隊首獲殊榮

美國矯正學會出版的矯正專刊，為公認的世界級的矯正專業期刊，每年學會在前一年該期刊所出版的案例中，評選出最具原創性和臨床治療結果優異的出版案例，在隔年的矯正年會上頒發最佳臨床案例（Case of the Year）獎，表揚作者對於臨床研究與治療上的卓越貢獻。

張慧男所領導的貝多芬團隊為華人首次獲選的治療團隊，獲得該項殊榮受到肯定。

張慧男在印地安那大學取得矯正博士學位後，一直致力臨床治療和專業教學的工作。他熱愛分享，寫作和演講，不僅將實務案例出版在英文的專業期刊上，也領導貝多芬團隊的醫師們，將案例製作成簡報影片發表在各大社群媒體上，與來自世界各地的專業人士交流。

從 2009 年開始，他徵選台灣牙醫系四升五年級學生，提供獎學金和臨床診所實習的機會，幫助學生在畢業選擇專科前，能有機會到診所環境實地考察。

除了熱愛矯正和教學外，張慧男還擁有專業的高爾夫球教練資格，工作之餘把高球作為休閒娛樂活動，還致力培育台灣青少年高球選手。

張慧男還曾自發創辦「貝多芬業餘高爾夫球邀請賽」，培養許多青年高球好手。

▲ 華裔醫師張慧男（前排左二）與專業人士交流。

B3 | 美西要聞(二)　世界日報　worldjournal.com　2019年6月9日 星期日 SUNDAY, JUNE 9, 2019

張慧男獲美國矯正學會期刊最佳案例獎

記者王全秀子／橙縣報導

貝多芬團隊負責人張慧男醫師的臨床案例，月前獲得美國矯正學會期刊（American Journal of Orthodontics and Dentofacial Orthopedics）年度最佳案例。他和共同作者之一，也是張慧男的指導教授Eugene. W. Roberts同台領獎。

華人團隊首獲殊榮

美國矯正學會出版的矯正專刊，為公認的世界級的矯正專業期刊，每年學會在前一年該期刊所出版的案例中，評選出最具原創性和臨床治療結果優異的出版案例，在隔年的矯正年會上頒發最佳臨床案例（Case of the Year）獎，表揚作者對於臨床研究與治療上的卓越貢獻。

張慧男所領導的貝多芬團隊為華人首次獲選的治療團隊，獲得該項殊榮受到肯定。

張慧男在印地安那大學取得矯正博士學位後，一直致力臨床治療和專業教學的工作，他熱愛分享，寫作和演講，不僅將實務案例出版在英文的專業期刊上，也領導貝多芬團隊的醫師們，將案例製作成簡報影片發表在各大社群媒體上，與來自世界各地的專業人士交流。

從2009年開始，他徵選台灣牙醫系四升五年級學生，提供獎學金和臨床診所實習的機會，幫助學生在畢業選擇專科前，能有機會到診所環境實地考察。

除了熱愛矯正和教學外，張慧男還擁有專業的高爾夫球教練資格，工作之餘把高球作為休閒娛樂活動，還致力培育台灣青少年高球選手。

張慧男還曾自發創辦「貝多芬業餘高爾夫球邀請賽」，培養許多青年高球好手。

▲華裔醫師張慧男（前排左二）與專業人士交流。（Florence提供）

華裔醫師張慧男獲得美國矯正學會期刊年度最佳案例。（Florence提供）

http://ep.worldjournal.com/LA/2019-06-09/B03

In Memoriam:
Dr. Burstone's Lecture in Croatia in 2005

Slavica Alpeza Stanicic

Founder, Alpex D.O.O., Zagreb, Croatia

I met Dr. Burstone in April 2005. He was lecturing mechanics at the first ortho course I organized in my newly founded company. I knew he was a master of mechanics in orthodontics and inventor of many orthodontic devices and therapeutic innovations. My first impression was more than positive. He was warm and friendly, very easy to make human contact with. The course was held in a beautiful summer resort on the northern Adriatic coast of Croatia and from the beginning there was a relaxed and pleasant atmosphere among the participants, most of which was on account of Dr Burstone's immediacy. But I was very worried because it was the beginning of my private business and my budget was very tight. The course was attended by only 29 participants. There would have been a lot more but, on behalf of some extremely negative propaganda motivated by personal interests of some people from our ortho official structures at the time, there were only 29 participants. Dr. Burstone did not fail to see my concerns. When the course ended, he asked me whether I was happy with the comments of the participants. The comments were wonderful, the course was impressive. Dr. Burstone unselfishly shared his knowledge and experience.

Fig. 1:
Dr. Burstone (left) lectured in Croatia in 2005. He took a photo with Slavica Alpeza Stanicic (right).

I told him how everyone was delighted and that prof. Dr. Legović, head of orthodontics at the University of Rijeka, said that this was the best course he ever attended. Professor Legović was close to 60 years of age and, in his career, attended many courses at home and abroad. Dr. Burstone was pleased, he smiled contentedly. Later during our dinner he asked me again if I was carrying some burden on my chest in any way connected to the course he gave. I decided to tell him the truth. He briefly fell silent and then looked at me with his kind eyes and said, I understand your concern but from now on there is no place to worry because I give up my honorarium. Make it my contribution to your young company and to the benefit of Croatian Orthodontics. I looked at him in disbelief. He just laughed at my expression. I will never forget his generosity. Dr. Burstone was, at the time, 79 years old but the look on his face was boyish and innocent. My company has survived all the problems with our malignant surroundings. Today I'm a veteran in my business. When I heard ten years later that Dr. Burstone died in the middle of his lecture, the first thing I thought was that he just wanted it to be that way. Because only great and noble people die in the way they want. He joined the angels where he belonged due to his gentle and noble spirit.

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	日期 (週五)	USC 課程精選、期刊導讀與特別演講 9:00 - 10:30	植牙案例報告 10:45 - 12:00（30 分鐘 / 人）	
1	3/22	張迺旭 醫師（芝加哥西北大學牙周病學碩士、台北醫學大學口腔研究所副教授） 專題演講：Interdisciplinary treatment plan of severe adult periodontitis: two case reports		
2	4/19	邱上珍 醫師（明尼蘇達大學牙周病學碩士、美國牙周病科專科醫師） 題目：Flap design and suture (含操作，需自備縫合器械＆縫線)		
3	5/31	郭芯妤 醫師（哥倫比亞大學口腔生物學碩士 紐約大學補綴科助理教授） 專題演講：Full arch implant prosthesis		
4	6/21	USC 課程精選：黃育新 醫師（國際矯正植牙學會院士）	蕭浩宜 醫師（美國南加州大學植牙研究所進修）	翁蔚任 醫師（高雄醫學大學牙醫學士）
5	7/26	蘇筌瑋 醫師（高雄醫學大學牙周病學碩士、國際矯正植牙學會理事長） 題目：VISTA & hard/soft tissue application		
6	8/23	黃怡豪 醫師（賓州天普大學口腔生物學碩士、台灣大學牙周病科兼任教授 ） 專題演講：Full-arch rehabilitation		
7	9/27	林森田 醫師（中山醫學大學學士、國際矯正植牙學會院士） 題目：What is All-on-4?	顧傑 醫師（美國南加州大學植牙專科訓練）	黃育新 醫師（國際矯正植牙學會院士）
8	10/18	郭芯妤 醫師（哥倫比亞大學口腔生物學碩士、紐約大學補綴科助理教授） 專題演講：Digital dentistry + Abutment selection		
9	11/29	專題演講：張燕清 主任（波士頓大學口腔生物博士、國防醫學院牙醫系副教授） 題目：Current advanced technology and technique in dental implant		
10	12/27	蘇裕隆 醫師（陽明大學牙醫學士、FB 前牙美學達人） 專題演講：前牙美學	邱上珍 醫師（明尼蘇達大學牙周病學碩士、美國牙周病科專科醫師）	張慧男 醫師（美國印第安那普渡大學齒顎矯正研究所博士）

本課表僅供參考，植牙論壇保留課程變動之權利。

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Feedback from the Beethoven International Workshop, May 2019

Nothing in words can describe how I feel about the course. It was far beyond my expectations. Excellent lecture and hands-on workshop by the best dentist himself, and all of staff worked really hard to make the whole course go well. We absorbed so much knowledge in just 2 days, and Dr. Chris Chang shared all of his knowledge and experience to us. A standing ovation should be given to Dr. Chris Chang and the team. I'm very impressed and love the way you all prepared and presented this course. It's really my best dental course experience ever!

Dr. Shirley Gautama,
INDONESIA

The workshop was comprehensive. Dr. Chris was eager to share his knowledge and experience during the workshop, answering questions and giving his point of view comprehensively. He has a great sense of humor which makes the lectures interesting and enjoyable. His presentations were simple and easy to understand - really amazing.

Special mention to Bella Chu and team who executed all the arrangements perfectly and made sure we were comfortable.

Our accommodation was in a great hotel and the meals provided were great. I thoroughly enjoyed my time there, made some new friends and learnt a lot.

Dr. Ashwin Varghese Thomas,
UNITED ARAB EMIRATES

The timing of all the lectures and clinical observations were very good and accurate. The quality of the presentation is "Second to none". There were so many OBS insertions in the clinical session that no one felt left out. The attendants were from so many different countries showed that Chris is well known and respected, a true world class orthodontist in our field. I was very touched by how humble Chris is, his sense of humor and his innovation ability. Perhaps, a bit more written material would help to jot our memory when we look back at the photos we took during the lectures.

I would like to say an enormous "thank you" to Chris and his team for running the course. I learnt a lot in these short three days. It has given me inspiration and new found confidence in my practice. My wife and I had an amazing time in Taiwan. We travelled to Yilan, and Taipei also. We loved our time here. We met so many people from different nationalities in the course who have a common interest. They are all so lovely people.

Dr. Simon Chen,
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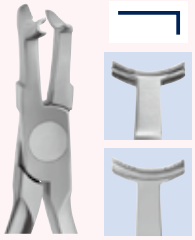

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W. Eugene Roberts

AJO-DO
American Journal of Orthodontics & Dentofacial Orthopedics

January 28, 2019

Shuang-An Lee
Chris C.H. Chang
W. Eugene Roberts
[illegible]
[illegible]
[illegible]

RE: CDABO Case Report of the Year Award

Dear Drs. Lee, Chang, and Roberts:

It is with great pleasure that I write to inform you that your article, "Severe unilateral scissors-bite with a constricted mandibular arch: Bite turbos and extra-alveolar bone screws in the infrazygomatic crests and mandibular buccal shelf," has been selected to receive the 2019 CDABO Case Report of the Year Award. Congratulations!

The College of Diplomates of the American Board of Orthodontics (CDABO) is composed of orthodontic clinicians who have passed all phases of the American Board of Orthodontics examination. The award was established by the College to recognize excellence in clinical orthodontics. It is given annually to the authors of the best Case Report published during the previous year in the *American Journal of Orthodontics and Dentofacial Orthopedics*.

The CDABO award will be presented at the annual meeting of the *AJO-DO* editorial board, which is held in conjunction with the AAO Annual Session. This year, the editorial board will meet Sunday, May 5, from 7:00 to 9:00 am, in Los Angeles, Calif. You and your co-authors are invited to join the board for this breakfast meeting and be recognized by the *Journal*'s editors and associates.

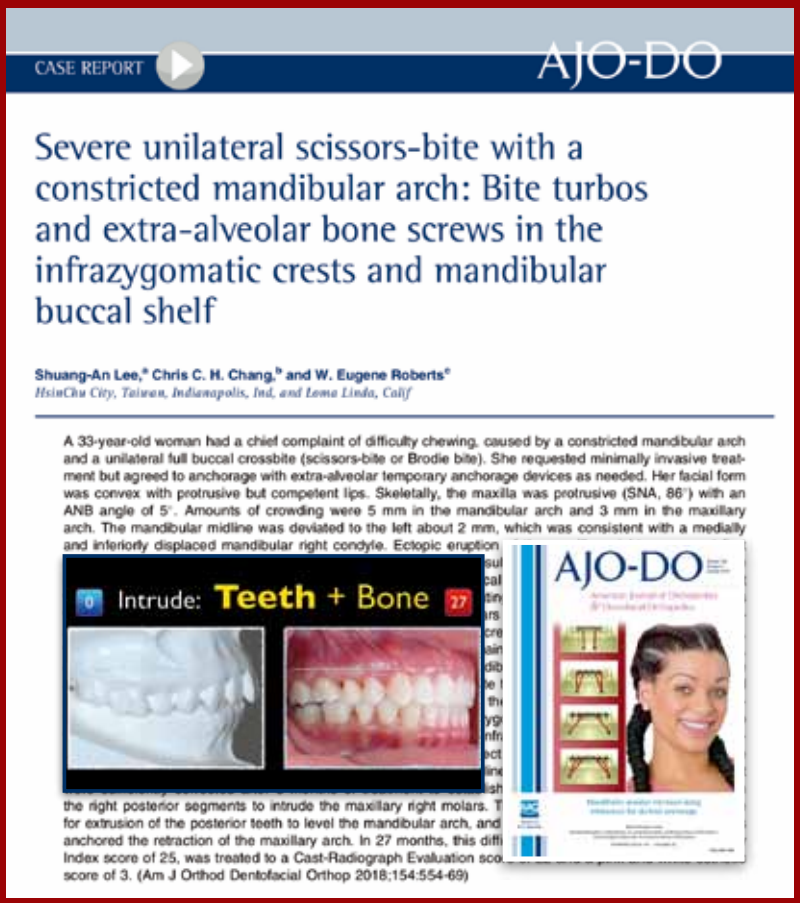
I hope that you plan to attend the AAO Annual Session in Los Angeles and can receive your certificate and recognition in person. Please let me know if you will be able to attend the AJO-DO Editorial Board Meeting on Sunday, May 5.

Again, I offer my congratulations for receiving this prestigious award.

Sincerely,

R Behrents

Rolf G. Behrents, DDS, MS, PhD
Editor-in-Chief, AJO-DO


CASE REPORT

AJO-DO

Severe unilateral scissors-bite with a constricted mandibular arch: Bite turbos and extra-alveolar bone screws in the infrazygomatic crests and mandibular buccal shelf

Shuang-An Lee,[a] Chris C. H. Chang,[b] and W. Eugene Roberts[c]
HsinChu City, Taiwan, Indianapolis, Ind, and Loma Linda, Calif

A 33-year-old woman had a chief complaint of difficulty chewing, caused by a constricted mandibular arch and a unilateral full buccal crossbite (scissors-bite or Brodie bite). She requested minimally invasive treatment but agreed to anchorage with extra-alveolar temporary anchorage devices as needed. Her facial form was convex with protrusive but competent lips. Skeletally, the maxilla was protrusive (SNA, 86°) with an ANB angle of 5°. Amounts of crowding were 5 mm in the mandibular arch and 3 mm in the maxillary arch. The mandibular midline was deviated to the left about 2 mm, which was consistent with a medially and inferiorly displaced mandibular right condyle. Ectopic eruption

the right posterior segments to intrude the maxillary right molars. T
for extrusion of the posterior teeth to level the mandibular arch, and
anchored the retraction of the maxillary arch. In 27 months, this diff
Index score of 25, was treated to a Cast-Radiograph Evaluation sco
score of 3. (Am J Orthod Dentofacial Orthop 2018;154:554-69)

AJO-DO, Volume 154, Issue 4, Pages 554–569

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Dr. Chris Chang's lecture tour in South America in June 2019. He gave a lecture together with Dr. Fernando Rojas Vizcaya in Cali, Colombia (left), led an OBS workshop in Bogotá, Colombia (center), and shared his insights in São Paulo, Brazil (right).