JDO

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The key to gummy smile correction focuses on intrusion of the entire maxillary arch. In the current case, the intrusion was effected orthodontically with TAD anchorage, followed by crown-lengthening surgery and selective laser gingivectomy to achieve the desired enamel exposure in the upper anterior segment.

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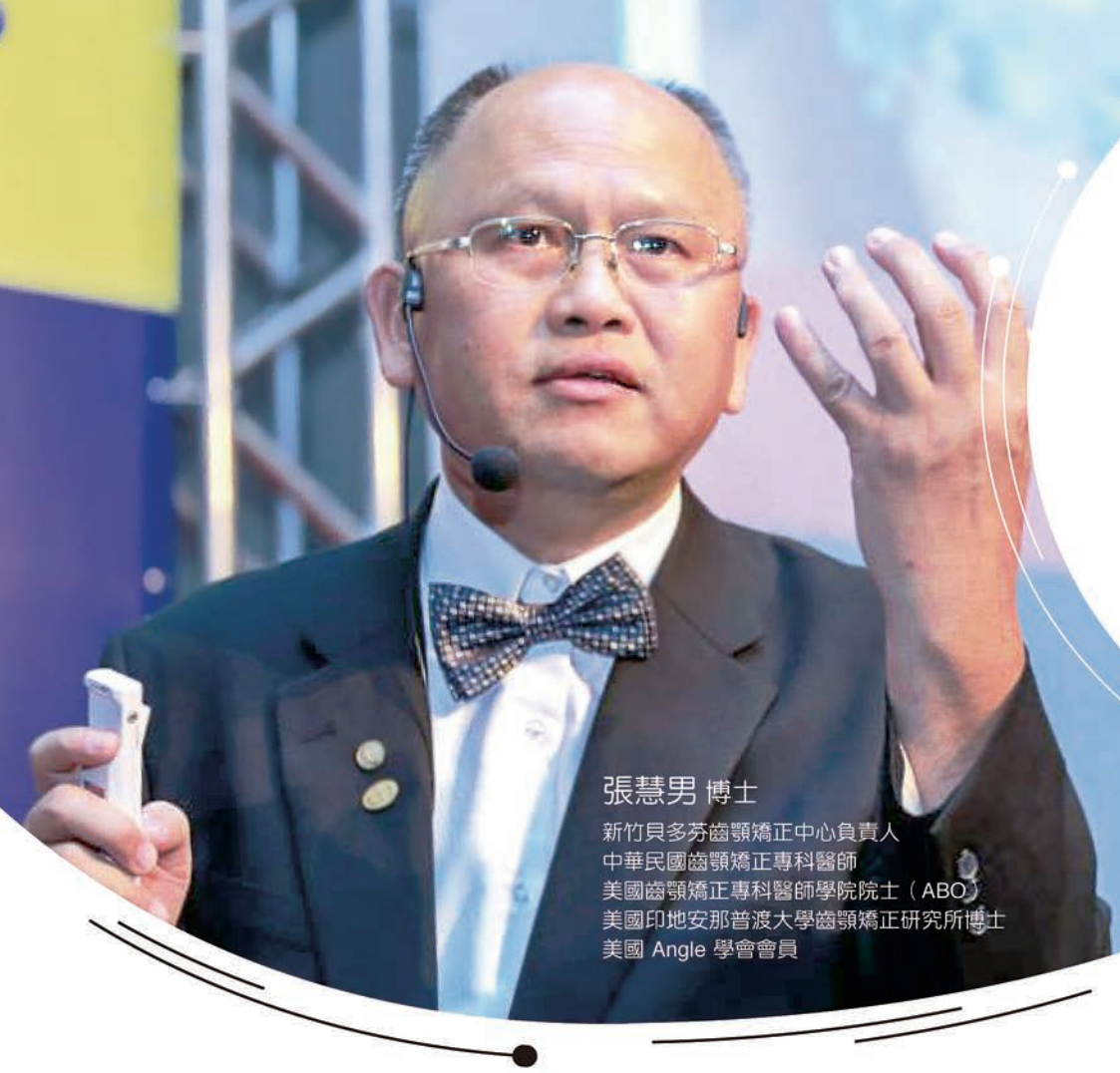


2020-21
熱愛學矯正

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。

Damon Master

(Thu) 9:00-5:00 中文授課

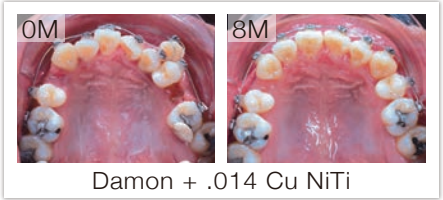
The Beethoven Damon Master Program, created by Dr. Chris Chang, is a two-year clinical program. Its hands-on orientation features case study-based diagnosis, analysis, treatment planning andresult evaluation. Combining in-class teaching assistants, after-class video review and chair-side observation,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

2020-21

Module 7 - **10/15**
Module 8 - **11/19**
Module 9 - **12/17**
Module 10 - **1/7**/21'

2021

Module 1 - **4/22**
Module 2 - **5/13**
Module 3 - **5/27**
Module 4 - **6/17**
Module 5 - **7/8**
Module 6 - **8/5**
Module 7 - **9/9**
Module 8 - **9/16**
Module 9 - **10/21**
Module 10 - **11/11**
Module 11 - **12/23**



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 XII

Module 1 - **7/21**
Module 2 - **8/11**
Module 3 - **9/8**
Module 4 - **10/20**
Module 5 - **11/17**
Module 6 - **12/15**
Module 6 - **1/12**/21'
Module 7 - **2/23**
Module 8 - **3/16**
Module 9 - **4/13**
Module 10 - **5/11**

Damon Clear

International Workshop

(Digital Orthodontics, OBS & VISTA)

English Class

The workshop provides a 3 day, advanced hands-on program to experienced Damon users. The program includes world-class lectures, model and surgical hands-on workshops and clinical observation on patient care and clinic management.

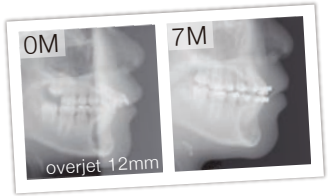
course@newtonsa.com.tw
+886-3-573-5676 #218 Annie

2020

Class 1 - ~~May 12-15~~ cancelled
Class 2 - **Dec 08-11**

2021

Class 1 - **May 18-21** Class 2 - **Dec 07-10**



Damon + Bite Turbo + Early Light Short Elastic

每次上課請依最新一期 JDO 公告為主

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Ortho Learning Post-COVID-19

Last week, I was invited to give a webinar, which had only been announced one month previously. Within that month, it had attracted over 3,000 doctors, a record for such an orthodontic webinar. It is amazing when one considers the logistics, effort, time, manpower, and costs it would have involved in bringing so many people under one roof. What makes it even more amazing is the fact that this was all arranged using only one software, Zoom.

For those of us who can remember the early days of the Internet, the quality of the Zoom connection now - no lags or buffering - as well as the crystal-clear audio just adds to the amazement! Even just a few years ago, this kind of event would only be able to cater for up to 100 participants, and the host would have been permanently crossing their fingers, hoping that the connection would be OK. Zoom is remarkably smooth, with super clear images, and also provides the ability to answer questions as soon as they have been asked.

Relaxing after the webinar, I realized that this might well have spelled the end of on-site presentations, something I had always suspected would happen; however, I never imagined it would happen this soon. This is probably one of the few good-positives to have emerged from the current COVID-19 situation, that cutting-edge technology can be pushed to the fore so quickly.

It also reminded me of the young boy who inspired me to learn the guitar after seeing him teaching on YouTube. I immediately realized the potential of teaching on such a platform, and, consequently, I set up my own YouTube channel to show the world how to straighten teeth. Today there are over 600 presentation videos on my YouTube channel, covering all aspects of orthodontics. In 2011, another great learning tool, 3D iBooks produced by iBooks Author software, also became available from Apple, a perfect combination of tutorial videos, texts, and diagrams. However, both of these tools miss just one thing - immediate communication between the hosts and participants.

Zoom has now taken center stage, offering new possibilities to communicate in real time on a global scale. Does this mean the end of on-site annual meetings and conferences? No more flying half way around the world to deliver a speech? Only time will tell.

As Warren Buffet once said, "*Stay where you are and you can achieve most of the jobs.*" Now, one can see this is real wisdom and so true, especially in the new normal of COVID-19. This is really the moment to stay where we are without having to stop our learning.

I hope that you will join me as we Zoom along our path to glory.

Chris Chang PhD, ABO Certified, Publisher of JDO

Conservative Treatment for Severe Skeletal Class III Openbite Malocclusion: Reversing the Etiology of Interincisal Tongue-Posture

Abstract

Skeletal Class III malocclusion with bimaxillary protrusion and anterior openbite is a major esthetic and functional disability. A 15-year-old female presented for orthodontic consultation with excessive facial height (58%), concave profile (-5˚), facial asymmetry (chin deviated 5mm to the left), bimaxillary protrusion (SNA 85˚, SNB 89.5˚), and an intermaxillary discrepancy (ANB -4.5˚). The full-cusp Class III malocclusion was complicated with lower arch crowding (-5mm), anterior openbite (6mm), and posterior crossbite tendency. The Discrepancy Index (DI) was 70. A thorough diagnosis and assessment of etiology indicated an effective treatment plan: asymmetric molar extraction pattern (UR7, UL7, LR7, LL6), bone screw anchorage for retraction of the lower arch, and correction of anterior, interincisal tongue posture. This severe malocclusion was treated to a satisfactory result in 24 months without orthognathic surgery. The Cast-Radiograph Evaluation (CRE) score was 30. (J Digital Orthod 2020;60:4-16)

Key words:

Skeletal Class III, full-cusp Class III, molar extraction, anterior openbite, anterior tongue posture, posterior crossbite, asymmetrical extraction, passive self-ligating appliance

Introduction

A 15-year-9-month-old female presented for orthodontic consultation with the chief complaint of poor dentofacial esthetics and function. Specific concerns were facial protrusion, openbite, speech impediment, and compromised masticatory function. Clinical examination revealed a full-cusp (*>10mm*) Class III malocclusion bilaterally, which was complicated with anterior openbite, posterior crossbite, lower dental midline and chin deviation 5mm to the left, and an excessive lower facial height (*Figs. 1-3*). Medical and dental histories were within normal limits (*WNL*). There was no history nor evidence of temporomandibular dysfunction. The morphology of the malocclusion was consistent with an asymmetric airway-compensation: (*1*) low tongue posture, (*2*) incompetent lips, and (*3*) mandibular midline deviation.[1,2]

This case report focuses on an etiology-based diagnosis to treat a severe malocclusion without orthognathic surgery in only 24 months. The direct comparisons of the start and finish photographs, casts, and radiographs are presented in Figs. 1-8. Superimposed cephalometric tracings before and after treatment are shown in Fig. 9.

Eric Hsu,
Lecturer, Beethoven Orthodontic Course (Left)
Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center)
W. Eugene Roberts,
Editor-in-Chief, Journal of Digital Orthodontics (Right)

Fig. 1: Pre-treatment facial photographs

Fig. 2: Pre-treatment intraoral photographs

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

Fig. 4: Post-treatment facial photographs

Fig. 5: Post-treatment intraoral photographs

Fig. 6: Post-treatment study models (casts)

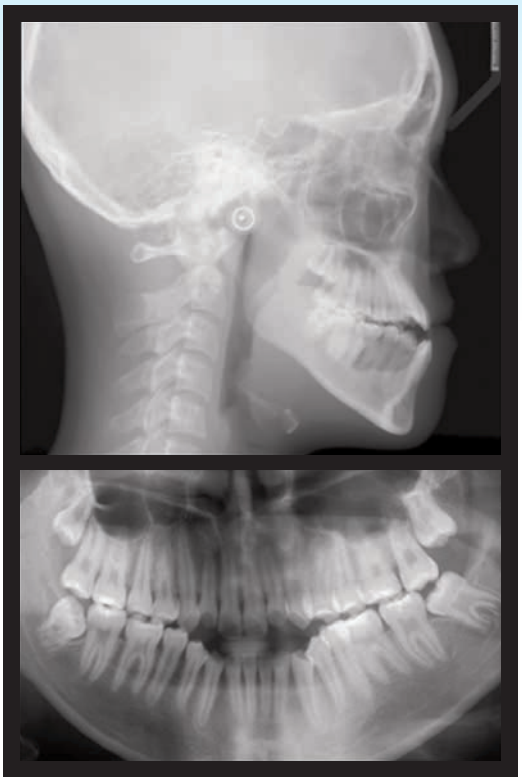

Fig. 7:
Pre-treatment cephalometric and panoramic radiographs document the original dentofacial morphology.

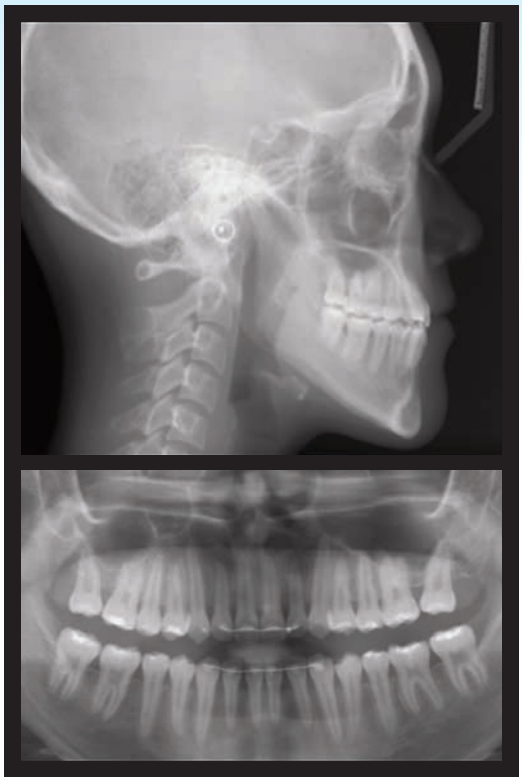

Fig. 8:
Post-treatment cephalometric and panoramic radiographs reveal the dentofacial morphology immediately after fixed appliances were removed.

Fig. 9:
Pre- (black) and post-treatment (red) cephalometric tracings are superimposed on the anterior cranial base (left), the maxilla (upper right), and the stable internal structures of the mandible (lower right). See text for details.

The dental nomenclature for this report is a modified Palmer notation. Upper (*U*) and lower (*L*) arches, as well as the right (*R*) and left (*L*) sides, define four oral quadrants: UR, UL, LR, and LL. Teeth are numbered 1-8 from the midline in each quadrant, e.g., a lower right first molar is LR6.

Diagnosis

Facial:

- Length: *Long tapered face, Na-ANS-Gn 58% (Table 1)*
- Convexity: *Concave profile, G-Sn-Pg'= -5˚*
- Symmetry: *Chin deviation 5mm to the left*
- Smile: *Insufficient maxillary incisal exposure*
- Hypermentalis Strain: *Incompetent lips*

Skeletal:

- Intermaxillary Relationship: *Bimaxillary protrusion (SNA 85˚, SNB 89.5˚, ANB -4.5˚)*
- Mandibular Plane: *WNL (SN-MP 34.5˚, FMA 27.5˚)*
- Vertical Dimension of Occlusion (*VDO*): *Excessive Na-ANS-Gn (58%)*
- Symmetry: *Mandible deviated to the left about 5mm.*

Dental:

- Classification: *Full-cusp Class III relationship bilaterally*
- Overbite: *-6mm (anterior openbite)*
- Overjet: *-6mm (anterior crossbite)*
- Posterior Crossbite: *UL4, UL5, UL6 in lingual version*
- Symmetry: *Upper dental midline deviated from facial midline 1mm to the right. Lower dental midline deviated 5mm to the left.*

The ABO Discrepancy Index (*DI*) was 70 as shown in the subsequent worksheet (*Workshseet 1*).[1,2]

Treatment Objectives

The treatment objectives were: (*1*) retract and posteriorly rotate the lower arch; (*2*) align both arches; (*3*) correct openbite; (*4*) align dental midlines; (*5*) improve the facial profile; and (*6*) optimize smile esthetics.

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA˚ (82°)	85˚	84˚	1˚
SNB˚ (80°)	89.5˚	86˚	3.5˚
ANB˚ (2°)	-4.5˚	-2˚	2.5˚
SN-MP˚ (32°)	34.5˚	38˚	3.5˚
FMA˚ (25°)	27.5˚	31˚	3.5˚
DENTAL ANALYSIS			
U1 To NA mm (4mm)	8.5	6	2.5
U1 To SN˚ (104°)	121.5˚	111.5˚	10˚
L1 To NB mm (4mm)	4.5	1.5	3
L1 To MP˚ (90°)	71.5˚	68˚	3.5˚
FACIAL ANALYSIS			
E-LINE UL (-1mm)	-4.5	-4.5	0
E-LINE LL (0mm)	0.5	-3	3.5
Convexity: G-Sn-Pg' (13°)	-5˚	1.5˚	6.5˚
%FH: Na-ANS-Gn (53%)	58%	60%	2%

Table 1: Cephalometric summary

Treatment Alternatives

Plan A.

Camouflage treatment is directed at correction of the occlusion and masking the skeletal discrepancy: (*1*) asymmetric extraction for midline correction: UR7, UL7, LL7, and LR6; (*2*) buccal shelf bone screws and Class III elastics for retracting the mandibular arch; and (*3*) counseling, exercises, and lingual spurs to correct interincisal tongue posture. These mechanics are designed to produce an optimal Class I dental midline correction and improve the concave facial profile (*Fig. 10*).

Plan B.

Orthognathic surgery is often the preferred approach to correct the skeletal component of a Class III malocclusion with an openbite. However, the patient and her parents refused orthognathic surgery, which was previously suggested by multiple orthodontists. Thus, camouflage treatment (*Plan A*) was the family choice.

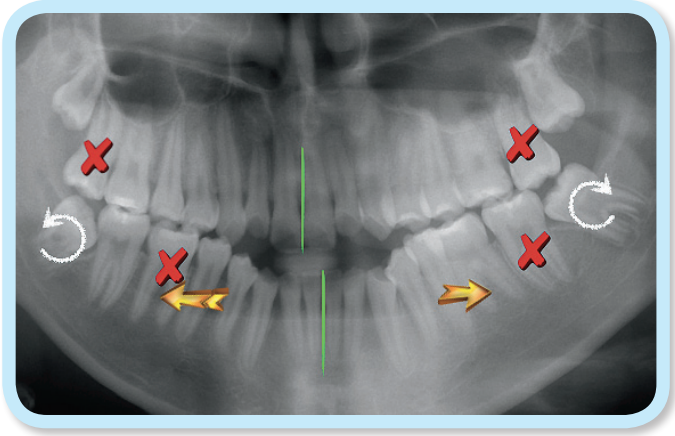

Fig. 10:
The treatment plan required extraction of four molars and space closure to correct the anterior crossbite. See text for details.

Appliances and Treatment Progress

A 0.022-in slot passive self-ligating (*PSL*) bracket system, Damon Q® (*Ormco, Brea, CA, USA*), was selected, with the following third-order adjustments: low torque brackets on upper incisors, and low torque brackets bonded inversely (*upside down*) on lower incisors.[1,2] All archwires and auxiliaries were supplied by the same manufacturer. The lower arch was bonded at the start of treatment (*0M*), and the upper arch was bonded one month later (*1M*). The initial mechanics for both arches were 0.014-in CuNiTi archwires fitted with resin balls bonded on the ends to prevent mucosal irritation (*Table 2*).

After 4 months of active treatment, crowding on both arches were relieved, so both archwires were changed to 0.014x0.025-in CuNiTi. In the 8th month of treatment, the upper archwire was changed to 0.017x0.025-in TMA, and lower archwire was changed to 0.016x0.025-in stainless steel (*SS*). Then Class III elastics (*Fox, 1/4-in, 3.5-oz*) were applied.

In the 9th month of treatment, the anterior openbite was resolved (*Fig. 11*), and UL8, LR8, and LL8 had erupted spontaneously (*Fig. 11*). Three months of Class III elastics (*Fox 1/4", 3.5oz.*) corrected the anterior crossbite (*Fig. 12*). Brackets were bonded on lower 3rd molars, and the lower archwire was replaced with a 0.016-in CuNiTi. In the 15th month of treatment, electrocautery exposed the UR8 to facilitate eruption (*Fig. 13*). Brackets were bonded one month after the tooth had erupted (*17M*). At the same appointment, a 0.014-in CuNiTi archwire was engaged.

After 19 months of active treatment, a 2x12-mm bone screw (*OBS®, iNewton, Inc., Hsinchu City, Taiwan*)

Fig. 11:
Anterior openbite was resolved in 9 months. Note the third molar erupted spontaneously.

Fig. 12: Anterior crossbite was corrected with only Class III elastics.

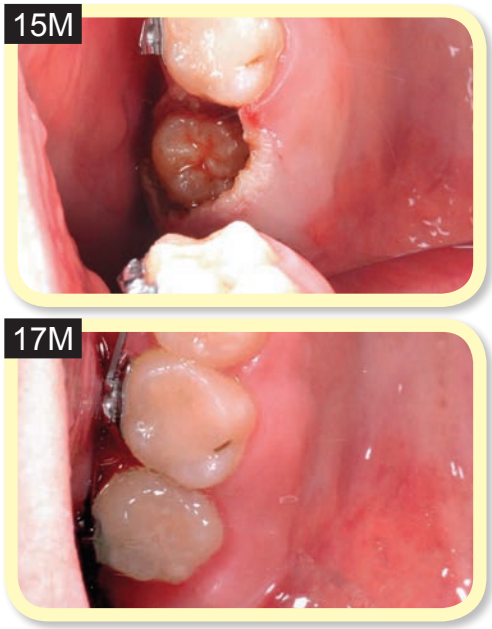

Fig. 13:
Electrocautery at 15 months into treatment (15M) removed soft tissue impeding the eruption of the UR8. The tooth erupted two months later (17M).

was inserted in each buccal shelf for the last two months of lower arch retraction. Both bone screws were removed at twenty-one months (*21M*). To improve the occlusal contacts, archwires were sectioned distal to second premolars, and vertical (*up-and-down*) elastics (*Chipmunk, 1/8-in, 3.5-oz*) were applied. The mechanics for treatment for the current patient are illustrated in the Archwire Sequence Chart (*Fig. 14*).

After 24 months of active treatment, all fixed appliances were removed. A diode laser was used to improve soft tissue contours in the upper anterior segment to enhance pink and white esthetics.

Treatment Results

Facial esthetics, dental alignment, and intermaxillary occlusion were remarkably improved (*Figs. 4-6*). No periodontal problems were noted. The post-treatment panoramic radiograph documented acceptable root parallelism, except for the UR6, UL7, and LL2 (*Fig. 8*), which are reflected in the CRE score. Superimposed cephalometric tracings documented that the mandibular arch was retracted about 7mm with Class III elastics and buccal shelf bone screw anchorage (*Fig. 9*). The axial inclination of the upper incisor (*U1-SN*) was decreased 10˚ during treatment (*121.5˚ to 111.5˚*), and the axial inclination of the lower incisors (*L1-MP*) was relatively well-maintained despite considerable retraction (*71.5˚ to 68˚*). Correction of the posterior crossbite and extrusion of the mandibular arch increased the mandibular plane angle (*SN-MP*) by 3.5˚ (*Table 1*). The tongue anterior postural problem resolved spontaneously as the dental alignment was corrected (*Figs. 4-6*), so no

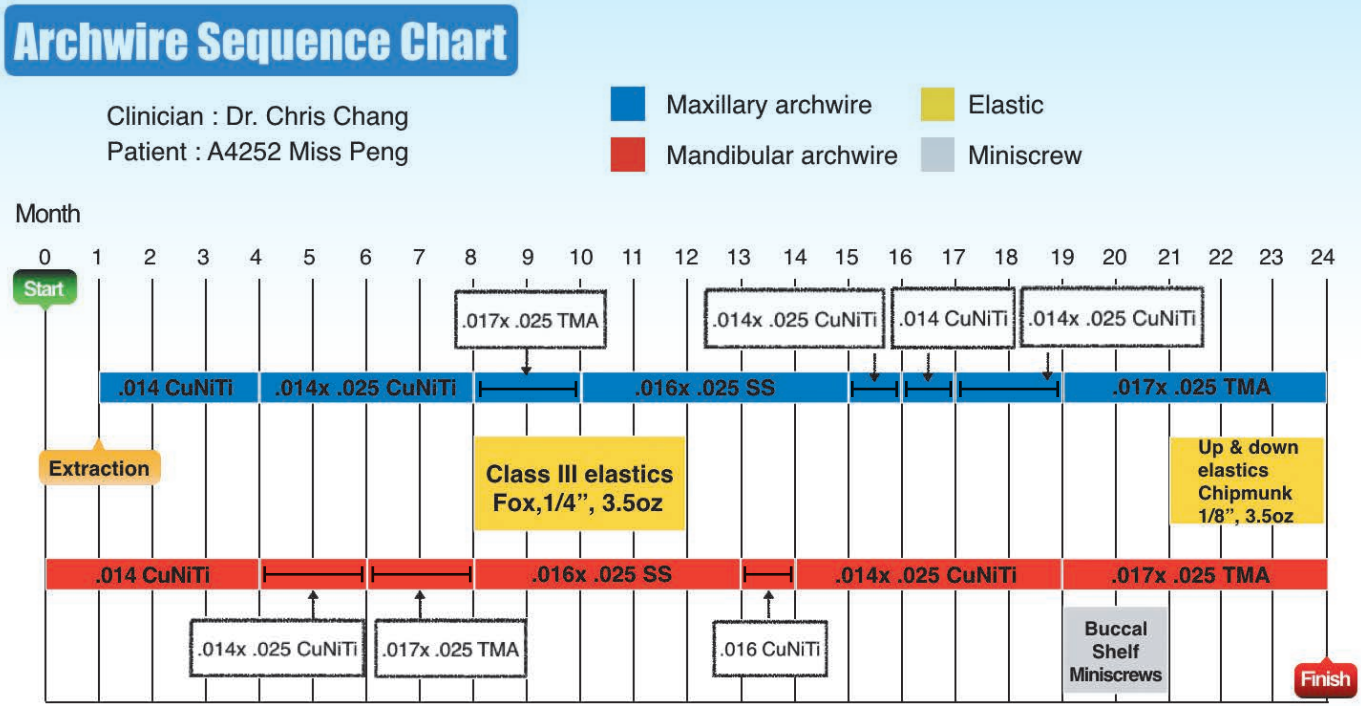

Fig. 14:
The Archwire Sequence Chart shows all the mechanics of treatment. Principal archwires are shown for the maxillary and mandibular arches in blue and red respectively. Additional archwires (black boxes) were used for special purposes as indicated.

myofunctional therapy was needed. The ABO CRE score was 30 points, as shown in the supplementary CRE chart (*Worksheet 2*).[3] The principal deficits in the final alignment were marginal ridge discrepancies and buccal lingual inclination of posterior teeth. The Pink and White dental esthetic score was 2 points (*Worksheet 3*).[4] The patient was well satisfied with the result.

Retention

Fixed lingual retainers were placed on all maxillary incisors, and from canine to canine in the mandibular arch. Clear overlays were delivered for each arch. The patient was instructed to wear them full time for the first month and nights only thereafter. Instructions were provided for home hygiene, as well as for maintenance of the retainers.

Discussion

Prevalence of Class III malocclusion ranges from 0.8% to 4.0% in Caucasians, but it is much more prevalent among the Chinese and Japanese (*12-13%*).[5] The etiology of Class III malocclusion may be genetic and/or environmental.[6-9] Incisal interference may be compensated by protruding the mandible to achieve a more functional occlusion, which results in anterior crossbite.[6] Compensations for breathing problems (*sleep apnea*) are well documented.[7-15] Airway compromise may be compensated by anteriorly posturing the mandible to achieve a more patent airway.[6,9,10] A low tongue posture with the distal segment positioned between the teeth is the etiology of anterior openbite.[8,9]

The appropriate diagnosis and treatment plan focused on the etiology of a skeletal Class III

openbite malocclusion (*Figs. 1-3, and 7*), which was treated to a pleasing result (*Figs. 4-6, and 8*) in only 24 months without orthognathic surgery. The major problems were (*1*) severe openbite (*6mm*), (*2*) full-cusp Class III malocclusion, (*3*) dental midline deviation (*5mm*), and (*4*) unfavorable anterior root torque.

1. Openbite

The proximal cause (*etiology*) of anterior openbite is interincisal resting tongue position (*Fig. 15*). To swallow, patients with an anterior openbite must protrude the tongue between the incisors to achieve an anterior seal. However, transient loads associated with that occasional reflex do not move teeth. The constant position of the tongue between the incisors at rest dictates tooth position, and is the etiology of openbite.[8] Upper arch expansion provided space for an appropriate tongue rest position, and lingual spurs helped guide the tongue to its correct postural position. The combination of this form of treatment and the spontaneous correction of tongue posture by the patient resulted in resolution of the anterior openbite in 9 months (*Figs. 15 and 16*).

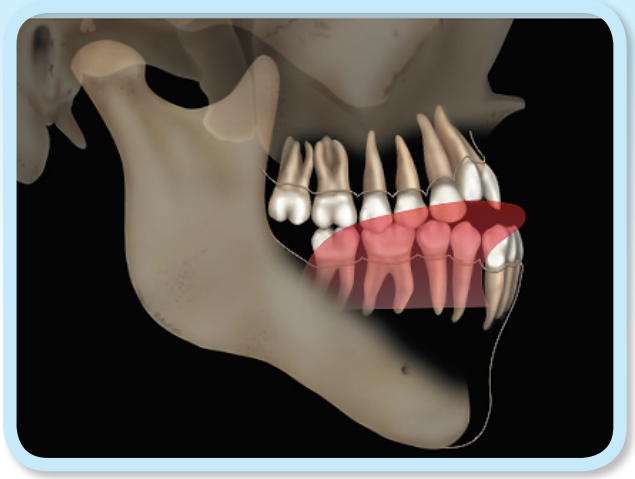

Fig. 15:
Low tongue position with an interincisal posture of the tip (distal segment) resulted in anterior openbite.

Fig. 16:
Tongue spurs for tongue position correction remind the patient to elevate and retract the tongue.

2. Full-Cusp Class III Malocclusion

Asymmetric molar extraction in all four quadrants provides the space needed to correct the negative overjet and to improve the posterior intercuspation. Extraction of 4 premolars (*mandibular first and maxillary second*) failed to provide appropriate space to correct the molar relationship. A full-cusp Class III molar relationship can be corrected by retracting and posteriorly rotating the lower arch.[1,2] For this patient, the first and second molar extractions provided excellent lower anchorage to correct the anterior crossbite with space closure and retraction of 12 teeth. However, the lower molars were not intruded, so the bite was opened as evidenced by the 3.5˚ increase in the MPA (*Fig. 9, Table 1*). The bite opening did improve the facial convexity by 6.5˚.

3. Midline Deviation

A conventional solution of midline deviation is using unilateral elastics, but that approach tips teeth and rarely achieves a skeletal effect. Buccal shelf miniscrews are osseous anchorage to achieve a skeletal effect. However, both elastics and buccal

shelf bone screws require a long time to correct large midline deviation (*5mm*), and would produce compromises in intercuspation. On the other hand, asymmetric molar extraction is a simple approach for correcting the deviation with differential space closure (*Figs. 5 and 6*).

4. Unfavorable Anterior Root Torque

The maxillary (*U1-SN 121.5°*) and mandibular (*L1-MP 71.5°*) incisors were compensated prior to treatment (*Table 1*). Class III elastics exacerbate the problem, so low torque brackets were indicted for the upper incisors, and high torque brackets were preferred for the lower incisors. There are no high torque brackets designed for lower incisors, so low torque brackets were bonded inversely (*upside down*) to achieve the desired torque (*Fig. 17*).

Conclusions

Careful assessment of the etiology is essential for efficient management of severe skeletal Class III malocclusion with anterior open bite. The patient must understand the etiology of the malocclusion to appreciate his/her responsibility for correcting the problem, and particularly for maintaining the correction. Most Class III malocclusions are a developmental anomaly that can be corrected by reversing the etiology of the problem(s). Adequate patient cooperation based on knowledge of the etiology of the malocclusion is essential for correction and maintenance of the outcome.

Fig. 18 documents the current condition of the patient 2 years post-treatment.

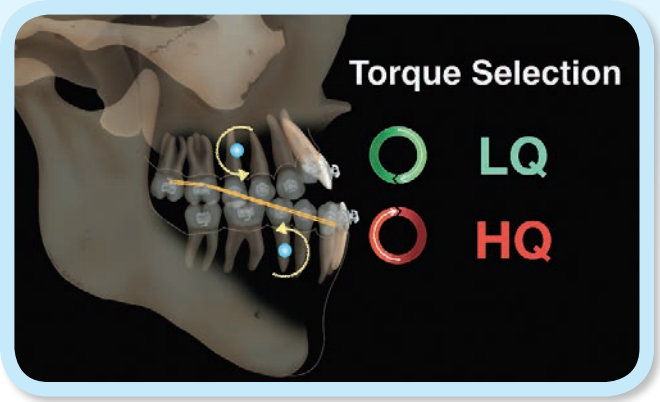

Fig. 17:
Low torque brackets for upper and high torque brackets for lower anterior segments compensate the side effects of Class III elastics.

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Fig. 18: Facial and intraoral photographs at 2-year follow-up

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 70

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 = 16

Total = 16

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 = 26

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 = 11

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 4

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° 2 x 1 pt. = 2

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 = 6

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. =	3
Addl. treatment complexities	_____ x 2 pts. =	_____

Identify:

Total = 5

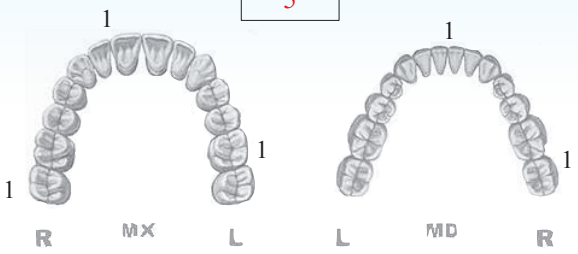
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 30

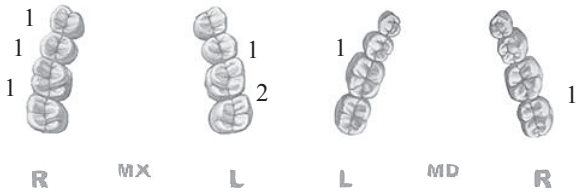
Alignment/Rotations

5



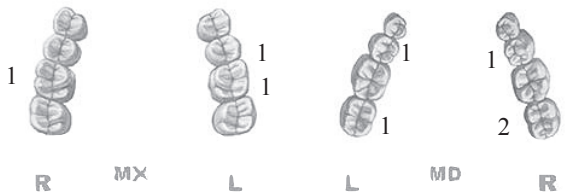
Marginal Ridges

8



Buccolingual Inclination

8

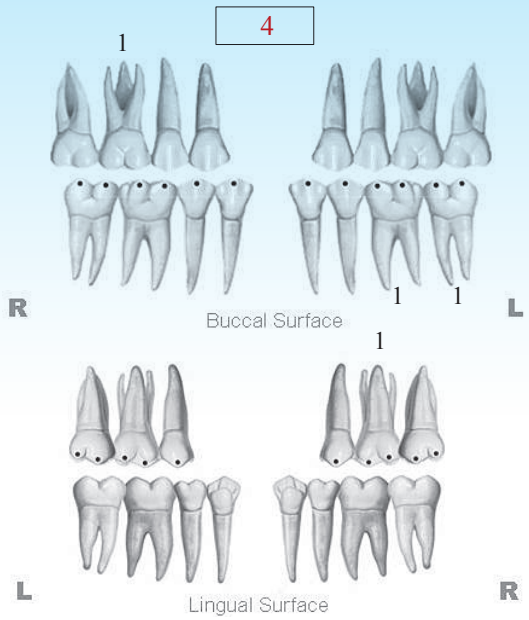


Overjet

1

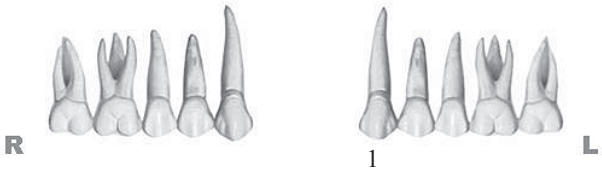
Occlusal Contacts

4



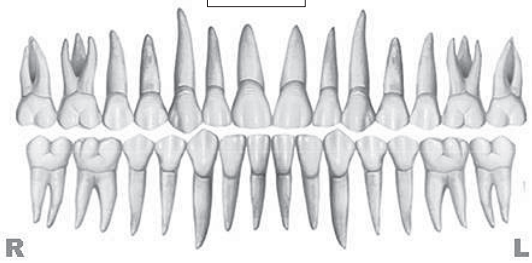
Occlusal Relationships

1



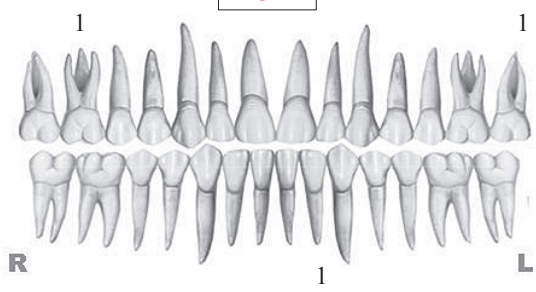
Interproximal Contacts

0



Root Angulation

3



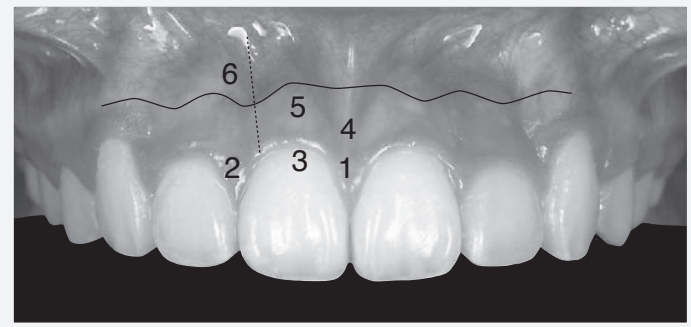
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 2

1. Pink Esthetic Score

Total = 1

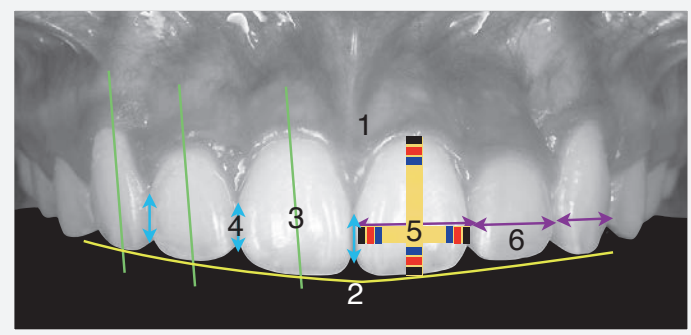


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

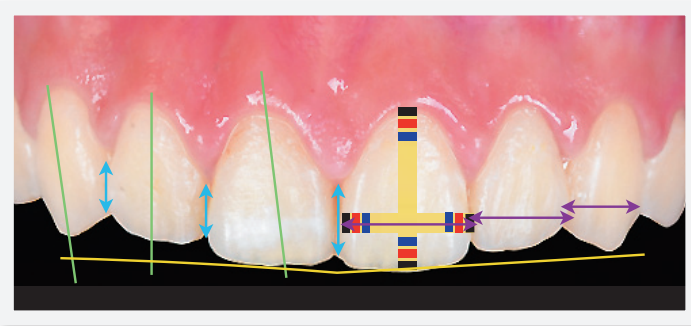
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	(0)	1	2
4. Level of Gingival Margin	0	(1)	2
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 1



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

Products

Dental Products Essential Kit

NEW

Double Retractors 2.0 Autoclavable!

Double Retractors x2, Black Board x2

While keeping the same lip & cheek two-way design, the new Double Retractors 2.0 is upgraded to medical grade PPSU. This new material is more durable, resilient and most importantly, autoclavable. Its smooth edges and translucent quality make it the best aid to perfect intra-oral photography.

Stainless Steel Mirror

Strong, durable stainless steel, autoclave-proof, the specially designed size, shape and thickness ensure maximum intra-oral view without sacrificing patient comfort.

Bite Turbo 2.0

Handle x1, BT molds x6, BT extended molds x6, Button molds x6

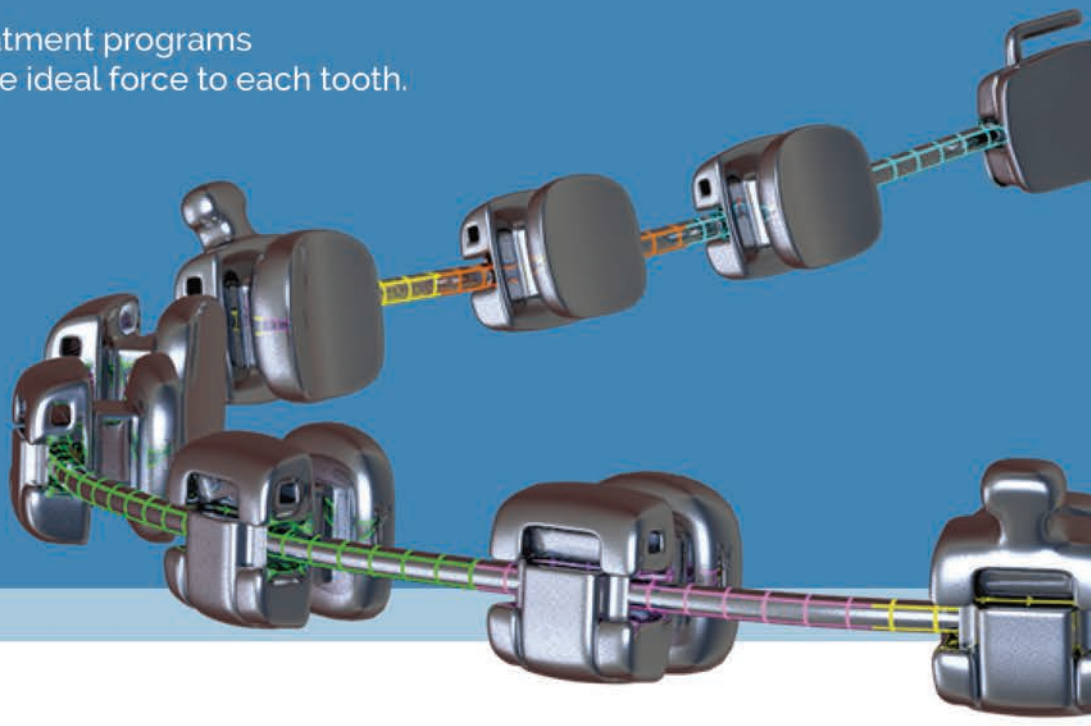
A simple but power set of tools to correct severe deep bite and cross efficiently. The bite turbos and lingual button molds, made with silicon and filled with flowable resin, can be reused and adjusted depending on treatment progress. The longer one allows you to solve all kinds of deep bite and large horizontal overjet.

Ormco

TWO WIRES INSTEAD OF FOUR

Introducing SmartArch,™ designed to allow clinicians to move into a finishing wire after just two archwires.

The patented laser treatment programs SmartArch to deliver the ideal force to each tooth.



NEW SMARTARCH™

Laser Engineered CuNiTi

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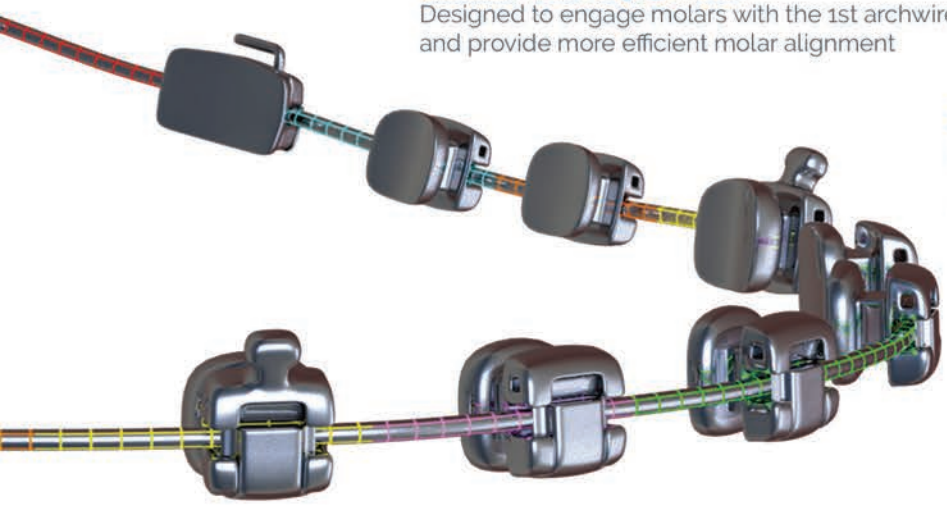
NEW SMARTARCH™

Laser Engineered CuNiTi

Fewer Wire Changes Ideal Force for Each Tooth



Efficient Molar Engagement
Designed to engage molars with the 1st archwire and provide more efficient molar alignment

7 Distinct Force Zones
Programed to deliver the ideal force to each individual tooth and equalize pressure along the PDL

Reduced Friction
Laser processing reduces friction between wire and bracket surfaces, promoting overall treatment efficiency

Computer Engineered
Engineered using finite-element-analysis, the SmartArch design accounts for variations in inter-bracket distance, root size, and the root-to-crown relationship

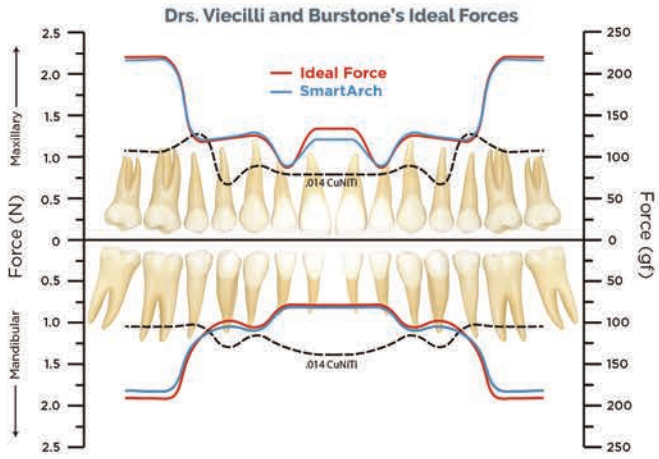
Less Wire Disengagement
Increased posterior stiffness designed to reduce likelihood of disengagement from buccal tubes and may reduce associated emergency appointments

The Science Behind SmartArch

A patented, pulsating laser programs SmartArch to deliver forces closely matching Drs. Viecilli and Burstone's established ideals. By applying ideal forces SmartArch promotes efficient tooth movement and may reduce overall treatment time.

SmartArch CuNiTi
200x

Standard CuNiTi
200x



Drs. Viecilli and Burstone utilized finite-element-analysis (FEA) to establish the ideal force load for each individual tooth

To learn more, contact your Ormco representative at 800.854.1741

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2020

Beethoven International Damon Master Program

Dr. Chris Chang
DDS, PhD. ABO certified, Angle Midwest
Beethoven Orthodontic Center, Taiwan

Beethoven International Damon Master Program, led by the world-renowned Dr. Chris Chang, is a 10-module course tailored for clinicians who desire to master the Damon System's treatment protocols with the combined use of mini-screws. The versatile course structure, including on-site lectures and hands-on workshops, as well as live webinars, allows participants to receive maximum learning value without interruptions to their busy practice schedule. Sign up now to experience Dr. Chris Chang's renowned effective teaching style!

1. Hands-on workshop

The course covers practices on a typodont and computer training on Mac. You learn best when you can have real hands-on experiences.

2. Chairside learning

Participants will have a chance to conduct chairside learning and observe clinical treatment process in Beethoven Orthodontic Center.

3. Free course videos

Participants will be offered recorded course videos free of charge. You can learn in efficient way by reviewing the videos anywhere on an iPad.

- Fees include tuition, workshop supplies, 3 nights of hotel (twin occupancy), e-handouts (iBooks), and course videos (iPad format).
- Mac laptop installed with the latest OS and Keynote software is advised, but not required, for the Keynote workshop. No PC.

Course Schedule **Time:** 9AM-5PM (GMT +8)

Module 1 June 11 Thu (Webinar)

1. Selecting your ideal first case
2. Bonding position
3. Four stages of efficient orthodontic treatment

Practice: Clinical photography

Module 2 July 16 Thu (Webinar)

1. Soft & hard tissue diagnostic analysis
2. Big overjet correction

Practice: Patient photo management

Module 3 Aug 6 Thu (Webinar)

1. Excellent finishing
2. Retention & relapse

Practice: Ceph tracing

Module 4 Sep 17 Thu (Webinar)

1. Simplify your system
2. Extraction vs. non-extraction

Practice: Ceph superimposition & measurement

Module 5 Oct 29 Thu (Webinar)

1. Class III correction
2. Class II correction

Practice: Case report demo

▲ Computer training (Mac): 1:30-2:30 pm

▲ Special lecture: 1:30-2:30 pm

Module 6 Nov 26 Thu (Webinar)

1. Upper impaction
2. Lower impaction
3. Gummy smile correction

Topic: Modified VISTA (Dr. Bill Su)

Module 7 Dec 31 Thu (Webinar)

1. Asymmetry
2. Open bite

Topic: Modified 2X4 appliance in ortho treatment (Dr. Yu Lin Hsu)

2021

Module 8 Jan 14 Thu (Webinar)

1. Ortho-implant connection
2. Minor surgeries in orthodontics

Topic: Interdisciplinary approach (Dr. Grace Chiu)

Module 9 Mar 11 Thu (Webinar)

1. Aligner & TADs
2. Keys to aligner learning

Topic: Introduction to clear aligner treatment (Dr. Lexie Y. Lin)

Module 10 Apr 15-17 Thu-Sat

1. Model practice (Damon & OBS)
2. ABO DI, CRE workshop
3. Chair side observation
4. Clinic management
5. Keynote workshop: Photo taking and editing (template), Ceph tracing

Workshop in Taiwan (Newton's A & Beethoven Orthodontic Center)

Location: 2F, 25, Jianzhong First Rd., Hsinchu, Taiwan



+886-3-5735676 #201 michelle@newtonsa.com.tw Michelle Tsai

Interdisciplinary Conservative Treatment for Gummy Smile and Deep Bite

Abstract

***Diagnosis and Etiology**: A 23-year-old female presented with chief complaints of excessive gingival display ("gummy smile") and severe intermaxillary crowding (>7mm). She desired improved smile esthetics without orthognathic surgery. The constricted, underdeveloped arches suggested inadequate occlusal loading, probably associated with a relatively soft, refined diet. Increased facial height (56.5%), bimaxillary retrusion (SNA 78.5˚, SNB 74˚), and extrusion of the maxillary dentition were consistent with a transient juvenile airway problem. The Discrepancy Index (DI) was 33.*

***Treatment**: Interdisciplinary treatment involved dentofacial orthopedic alignment followed by maxillary anterior crown-lengthening surgery. All four first premolars were extracted to correct crowding. Skeletal anchorage was provided with three bone screws: infrazygomatic crests bilaterally, and another between the apices of the upper central incisors. Differential space closure with bone screw anchorage reduced lip protrusion, intruded the maxillary incisors, and achieved a near ideal Class I alignment. Surgical crown lengthening was performed in the maxillary anterior segment.*

***Results**: 25 months of interdisciplinary treatment achieved a near ideal dentofacial result as evidenced by a Cast-Radiograph Evaluation (CRE) score of 27, and a Pink & White dental esthetic score of 2. (J Digital Orthod 2020;60:22-35)*

Key words:
Gummy smile, deep bite, Class II malocclusion, bite-turbos, surgical crown lengthening, temporary anchorage devices, infrazygomatic crest, extra-alveolar, bone screws, etiology

Introduction

Gummy smile, excessive gingival exposure when smiling, is a common chief complaint (*CC*) for adults seeking orthodontic consultation. Previously, severe gummy smile was a clear indication for orthognathic surgery, but the expense and morbidity produced interest in less invasive camouflage treatment.[1] Temporary anchorage devices (*TADs*) and periodontal surgery enhance the capability for resolving gummy smile without resorting to undesirable orthognathic surgery.[1,2] OrthoBoneScrews (*OBS®s*) are TADs produced by iNewton, Inc. (*Hsinchu City, Taiwan*). A 2mm diameter stainless steel (*SS*) OBS® achieves extra-alveolar (*E-A*) anchorage in the infrazygomatic crest (*IZC*) region of the posterior maxillary arch;[2] while a 1.5mm SS OBS® is used for incisal anchorage near the root apices.[1,2] The primary objective for this case report is to present interdisciplinary treatment with OBS® anchorage and crown-lengthening surgery as a viable conservative option for complex malocclusions including gummy smile.

Lomia Lee,
Orthodontist, Mozart Orthodontics (Left)
Chi Huang,
Orthodontist, Mozart Orthodontics (Center left)
Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center right)
W. Eugene Roberts,
Editor-in-Chief, Journal of Digital Orthodontics (Right)

Diagnosis and Etiology

A 23-year-old female presented with a common CC: gummy smile and severe crowding in both arches (*Figs. 1-6*). She desired an attractive smile but was opposed to orthognathic surgery. Pre-treatment records revealed a straight facial profile (*Figs. 1 and 5*). The intra-oral examination showed that molar relationships were near Class I, but canine relationships were Class II (*Fig. 3*). The overbite was 5mm (*75%*) with severe crowding of >7mm in both arches (*Fig. 4*). The upper left canine was blocked out, i.e., outside the dental arch form (*Fig. 3*). A lateral cephalometric radiograph (*Fig. 5*) indicated retrusive arches, particularly the mandible (*SNA 78.5°, SNB 74°, ANB 4.5°*), steep mandibular plane angle (*SN-*

Fig. 1: Pre-treatment facial and intraoral photographs

MP 45°), and normal lip protrusion to the E-line (*0mm/1mm*) (*Table 1*). The panoramic radiograph was within normal limits (*WNL*), as was the radiographic assessment of the temporomandibular joint (*TMJ*) (*Figs. 6 and 7*). The ABO Discrepancy Index (*DI*) was 33 as shown in the subsequent worksheet (*Worksheet 1*).

Fig. 2:
Gummy smile, asymmetrical gingival display, and blocked-out canine are documented in a frontal photograph.

Fig. 3: Pre-treatment dental models (casts)

Fig. 4:
Inferior (left) and lateral (right) intraoral views show a 6mm anterior deepbite.

Fig. 5: Pre-treatment lateral cephalometric radiograph

Fig. 6: Pre-treatment panoramic radiograph

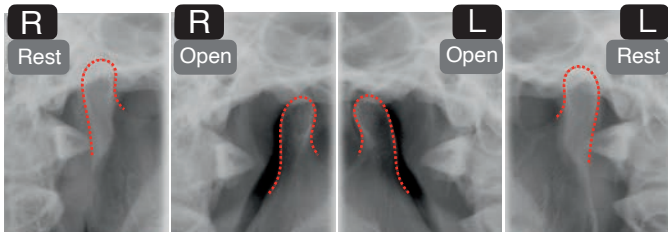


Fig. 7:
Pre-treatment TMJ transcranial radiographs are shown for the right (R) and left (L) sides in the rest and open positions. The mandibular condyles are outlined in red.

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	78.5°	78°	0.5°
SNB° (80°)	74°	74.5°	0.5°
ANB° (2°)	4.5°	3.5°	1°
SN-MP° (32°)	45°	44.5°	0.5°
FMA° (25°)	38°	37.5°	0.5°
DENTAL ANALYSIS			
U1 To NA mm (4mm)	5.5	3.5	2
U1 To SN° (104°)	105°	104°	1°
L1 To NB mm (4mm)	8.5	5	3.5
L1 To MP° (90°)	93°	82.5°	10.5°
FACIAL ANALYSIS			
E-LINE UL (-1mm)	0	-2	2
E-LINE LL (0mm)	1	-2	3
%FH: Na-ANS-Gn (53%)	56.5%	56%	0.5%
Convexity: G-Sn-Pg' (13°)	8°	8°	0°

Table 1: Cephalometric summary

Treatment Objectives

After a discussion of potential treatment options, the following goals were established:

(1) Extract four first premolars to relieve crowding.

(2) Align, level, and expand both arches to reduce buccal corridor width.

(3) Place three TADs: an OBS in each IZC, and an incisal miniscrew apical to upper central incisors.

(4) Correct the Class II buccal relationships with TAD anchorage.

(5) Reduce overbite by intruding upper and lower incisors.

(6) Correct the upper anterior crown-to-root ratio with surgical crown-lengthening.

Treatment Alternatives

The patient was opposed to orthognathic surgery, so the conservative treatment plan with bite turbos (*BTs*) and bone screws was the preferred option (*Figs. 8 and 9*). The conservative treatment procedures were explained: (*1*) occlusal inconvenience when the vertical dimension was opened with anterior bite turbos, (*2*) use of TAD anchorage, and (*3*) surgical crown lengthening with selective laser gingivectomy. After a thorough discussion of the entire treatment sequence, the patient provided informed consent for all the planned treatment procedures.

Treatment Progress

First premolars were extracted in each quadrant, and a 0.022-in Damon Q® (*Ormco, Brea, CA*) fixed appliance was installed. The maxillary central incisors and canines were bonded with high torque brackets,

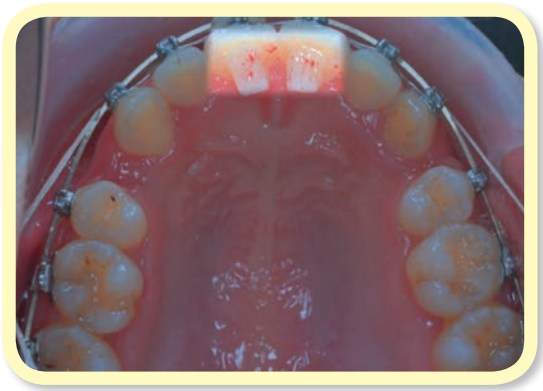


Fig. 8:
At 9 months into treatment, palatal bite turbos were placed on upper central incisors, and Class II elastics (Ormco, Fox) were applied.

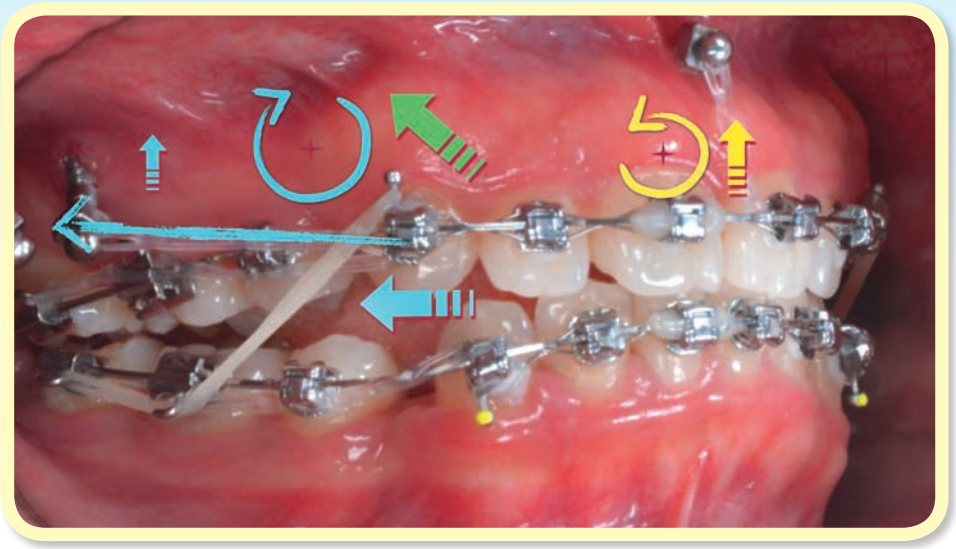


Fig. 9:
A 2D design of the intermaxillary mechanics on the right side is shown relative to bone screw anchorage apical to the maxillary molars and central incisors. In 3D, the mechanics and anchorage are symmetrical on both sides. The chain of elastics from the IZC bone screw (upper left) to the cuspid bracket is a line of force with posterior and vertical components (blue arrows) that produce a clockwise moment around the maxillary arch center of resistance (blue curved arrow). The maxillary anterior miniscrew (upper right) anchors an intrusive force (yellow arrow) that creates a counterclockwise moment (yellow curved arrow), tending to flare the maxillary incisors. The presumed resultant for all the applied loads is the green arrow that shows intrusion and retraction of the entire maxillary arch.

and standard torque brackets were used for the rest of the dentition. Both arches were leveled and aligned with the following archwire sequence: 0.014" CuNiTi, 0.014x0.025" CuNiTi, 0.017x0.025" TMA, and 0.016x0.025" SS (*Fig. 10*). All archwires and elastics were also supplied by Ormco.

Bite turbos were placed on the palatal surfaces of the upper central incisors at 9 months, and Class II elastics (*Fox 1/4-in, 3.5-oz*) were applied simultaneously (*Fig. 8*). Three bone screws (*TADs*) were placed at 10 months to anchor intrusion of the entire maxillary dental arch. A 2x12-mm OBS® was placed in each IZC, and a 1.5mm miniscrew was placed between the apices of the upper central incisors. The planned mechanics, diagramed in Fig. 9, corrected the malocclusion. Careful clinical management produced the desired functional occlusion with proper anterior guidance and adequate posterior support. After routine finishing and detailing procedures, all appliances were removed after 24 months of active treatment. Retention was accomplished with maxillary and mandibular clear overlay retainers. Surgical crown-lengthening was performed one month later. Detailed treatment progress is described in the discussion section.

Treatment Results

The patient was satisfied with the outcome: balanced profile, attractive smile, gummy smile correction, and good dental alignment (*Fig. 11*). The canine and molar relationships were corrected to Class I (*Fig. 12*). A functional occlusion with stable posterior support and near ideal anterior

Fig. 10: Treatment progress in months (M) is shown in six right buccal intraoral views arranged in clockwise order. See text for details.

Fig. 11: Post-treatment facial and intraoral photographs

guidance was established (*Fig. 13*). Cephalometric superimpositions before and after treatment showed that the maxillary first molars were translated about 3mm anteriorly (*Fig. 14*). The maxillary central incisors were intruded 1.5mm, and retracted about 3mm. Mandibular first molars were moved anteriorly about 2mm. The lower incisors were uprighted about 10˚, and intruded 1mm. The amount of counterclockwise rotation of the mandible was less than predicted (*Fig. 14*), but it was adequate to serve as a platform for the crown-lengthening procedure to achieve optimal correction of the gummy smile.

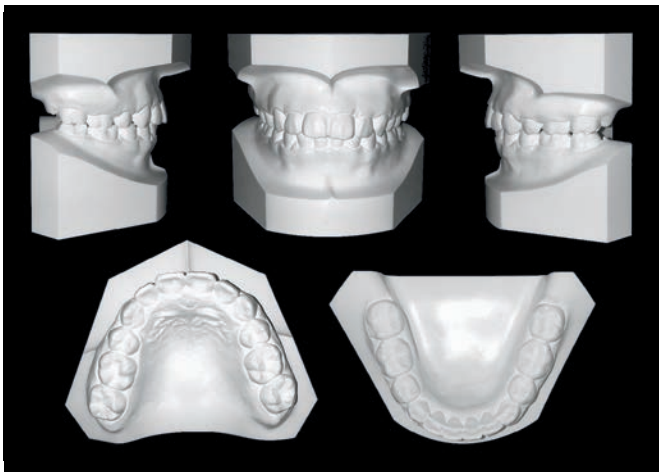


Fig. 12: Post-treatment dental models (casts)

Fig. 13: Post-treatment lateral cephalometric radiograph

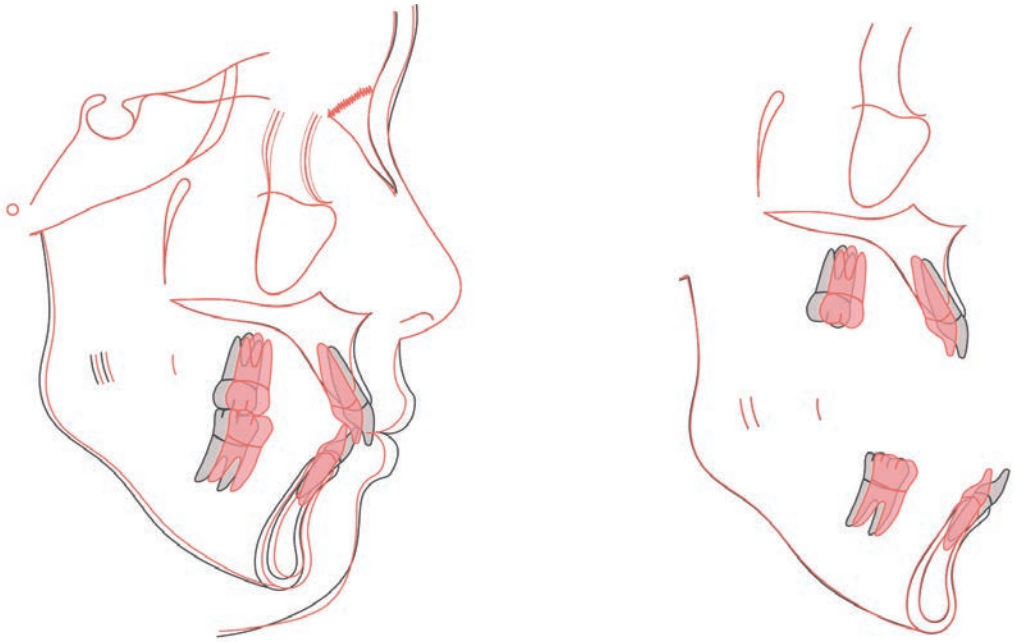


Fig. 14:
Cephalometric tracings superimposed on the anterior cranial base (left), on the maxilla (upper right), and on the mandible (lower right) show the dentofacial changes associated with 24 months of active treatment (red) compared to pre-treatment (black). See text for details.

Panoramic radiography at the end of the treatment showed near ideal root alignment (*Fig. 15*), and the follow-up TMJ evaluation was WNL (*Fig. 16*). The ABO Cast-Radiograph Evaluation (*CRE*) score was 27 points (*Worksheet 2*). The major CRE discrepancy was decreased occlusal contacts, which may reflect the anatomy of previous posterior dental restorations. The patient accepted the condition, and was not interested in further restorative treatment.

The Pink and White dental esthetic score was 2 points, as shown in the supplementary Worksheet 3. The patient was well satisfied with her dentofacial esthetics and functional occlusion.

Fig. 15: Post-treatment lateral panoramic radiograph

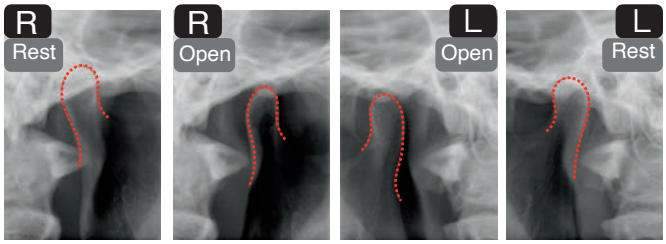


Fig. 16:
Post-treatment TMJ transcranial radiographs are shown of the right (R) and left (L) sides in the rest and open positions. The contours and articular relationships are WNL. See text for details.

Discussion

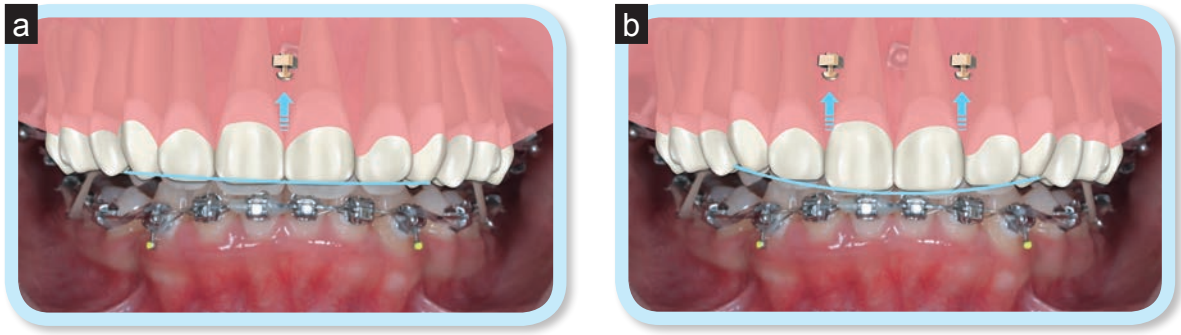
The term "*gummy smile*" refers to excessive gingival display >3mm during a full smile (*Fig. 17a*).[3] The specific problems for the current patient were: (*a*) short and hyper-mobile upper lip, (*b*) vertical maxillary excess, (*c*) extrusion of upper anterior dentition, and (*d*) altered passive eruption.[1,4] Myofunctional training to control expression of the smile is useful for a short and hyper-mobile lip, but structural correction is required for vertical maxillary excess, dental extrusion and altered passive eruption.[1,2,5] Gummy smile correction focused on intrusion of the entire maxillary arch (*Fig. 17b*). There were three keys for treatment:

Fig. 17:
(a) ***Post-Orthodontic Treatment****: frontal photograph revealed increased gingival exposure when smiling, due to excessive gingival tissue, short clinical crowns, and exaggerated lip elevation.*
(b) ***Final Outcome****: Crown-lengthening, laser gingivectomy, and more natural upper lip elevation resulted in an attractive smile.*

1. **Anterior Bite Turbo (BT)**: BTs were bonded on the lingual surfaces of upper central incisors for correction of deep bite. Anterior BTs are most effective when bite opening produces ideal anterior overbite and overjet, but apical loads on incisors commonly result in intrusion of upper and lower incisors.[6,7] BTs also serve as incisal stops to establish the level of the posterior occlusion at the desired vertical dimension of occlusion (*VDO*).[8] The desired plane of occlusion is produced by spontaneous eruption of the posterior dentition and orthodontic extrusion via NiTi archwire leveling and Class II elastics.

2. **TAD Force Design and Position**: According to Dellinger,[9] light forces (*50-100g*) provide optimal intrusion with minimal root damage. A force of approximately 20 gram/tooth,[7,9] is suggested for axial intrusion with minimal risk of root resorption.[10,11] The anterior position of the incisal miniscrew determines the line of force relative to the smile arc (*Fig. 18*). A 2-TAD design is preferred for distributing the intrusive force to protect the smile line. In contrast, a 1-TAD mechanism applies a single line of force between the upper central incisors that may flatten the smile arc. The latter is less invasive, but adjustment of a relatively stiff archwire is required in order to achieve an attractive maxillary anterior smile line (*Figs. 18 and 19*).[4]

3. **Surgical Crown Lengthening**: Osteoplasty is usually required in order to apically reposition the alveolar bone margin. This procedure is necessary to provide adequate biologic width for soft tissue attachment (*Fig. 19*). Measuring gingival sulcus depth and bone sounding under local anesthesia are important diagnostic tools for determining the appropriate level for crestal bone.[5] The present patient exhibited an adequate zone of attached gingiva, and the bone sounding depth was 3mm. Based on Coslet's classification of altered passive eruption,[12] the patient was classified as Type I-B (*excessive bone and gingiva*). Surgical crown lengthening and selective laser gingivectomy were used to enhance dental esthetics by apically repositioning the gingival margin while maintaining an appropriate biologic width (*Fig. 19*).[1] The cementoenamel junction (*CEJ*) is the anatomical reference for crown lengthening.[5]



■ *Fig. 18:*
Comparison of a 1-TAD (a) to a 2-TAD (b) design for intrusion of the upper anterior segment shows the advantage of the 2-TAD design for maintaining the smile arc (curved blue line). Achieving an adequate smile line with the 2-TAD mechanism requires a stiffer archwire adjusted to enhance the smile arc. See text for details.

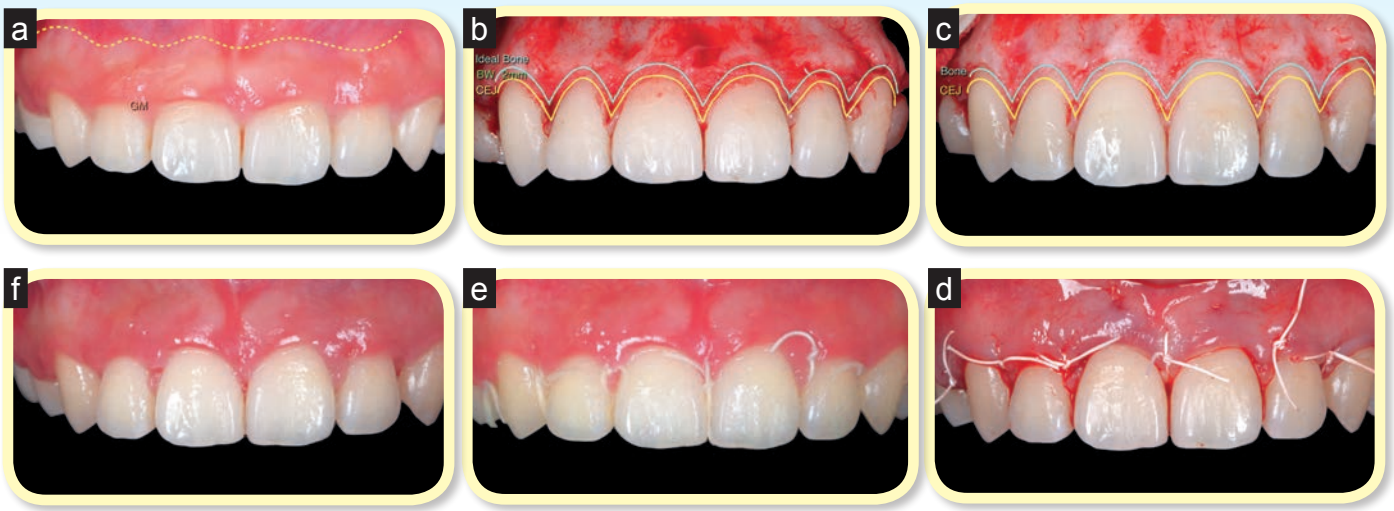


Fig. 19: Sequential steps in the surgical crown-lengthening procedure shown in a clockwise order were :

(a) Short clinical crowns with adequate keratinized gingiva are shown relative to the mucogingival junction (MGJ) depicted as a dotted line.

(b) Yellow line represents the CEJ, the biologic width (green BW) is 2mm of exposed root apical to the CEJ, and the blue line represents the ideal bone position.

(c) After osteoplasty, the CEJ (yellow line) is separated from the bone level (blue line) by a 2mm width of exposed root apical to the CEJ.

(d) Marginal gingiva is repositioned and sutured with 4-0 Gore-Tex® (Gore Medical Products, Flagstaff, AZ, USA).

(e) 10 days post-operatively, the sutures are removed.

(f) Gingival contours are shown after refinement with selective diode laser gingivectomy. Compare to image (a), note the wide band of attached gingiva inferior to the MGJ.

The relationship of the CEJ to the osseous crest was mapped. Bone removal was performed with a #5 round carbide bur to establish a uniform 2mm biologic width[13] for the anterior teeth. After gingival wound healing, diode laser gingivectomy was performed to refine gingival margins. Following the periodontal procedures, the patient was trained in natural lip elevation by observing her smile in a mirror. Attractive dentofacial esthetics when smiling was achieved (*Fig. 17b*).

Conclusions

Esthetic correction of deep-bite with a gummy smile is challenging. This case report is a step-by-step protocol for achieving an excellent outcome without orthognathic surgery. The maxillary arch was orthodontically intruded with TAD anchorage. Then, the desired enamel exposure (*crown length*) in the upper anterior segment was achieved with crown-lengthening surgery and selective laser gingivectomy. Natural lip elevation training was provided. A four-year follow-up evaluation of the patient documented excellent stability, good periodontal health, and routine expression of an attractive, natural smile (*Fig. 20*).

Acknowledgments

Thanks to Miss Laurel Shern for proofreading this article, and to Dr. Rungsi Thavarungkul for the beautiful illustrations.

Fig. 20: Four-year post-treatment follow-up records: facial and intraoral photographs

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 33

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 = 2

ANTERIOR OPEN BITE

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

Total = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

1 – 3 mm.	=	1 pt.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	4 pts.
> 7 mm.	=	7 pts.

Total = 7

OCCLUSION

Class I to end on	=	0 pts.
End on Class II or III	=	2 pts. per side _____ 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 = 2

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° 7 x 2 pts. = 14

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 16

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	2 x 2 pts. =	4

Identify: severe gummy smile
short clinical crowns

Total = 4

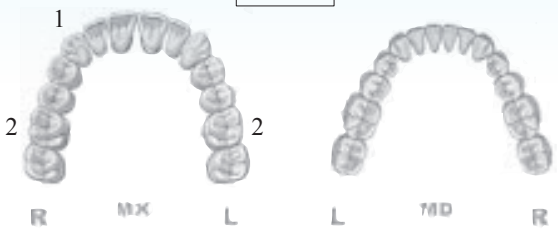
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 27

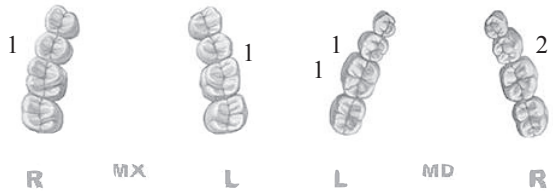
Alignment/Rotations

5



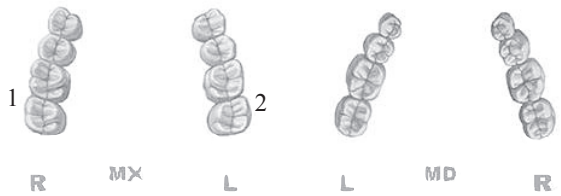
Marginal Ridges

6



Buccolingual Inclination

3

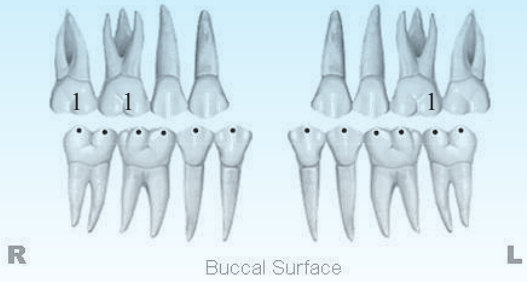


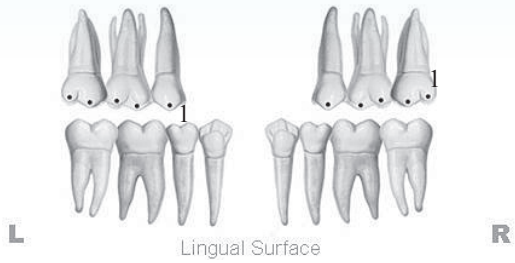
Overjet

4

Occlusal Contacts

5



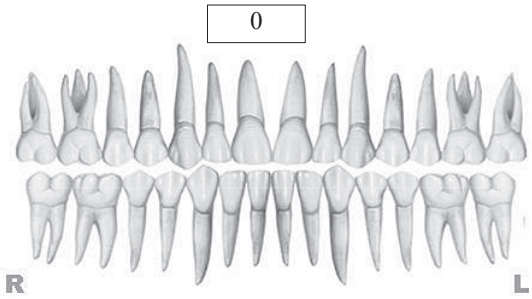


Occlusal Relationships

2

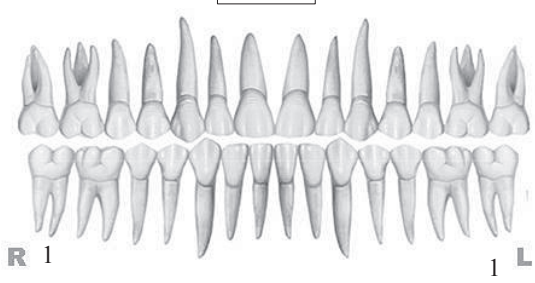
Interproximal Contacts

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: = 2

1. Pink Esthetic Score

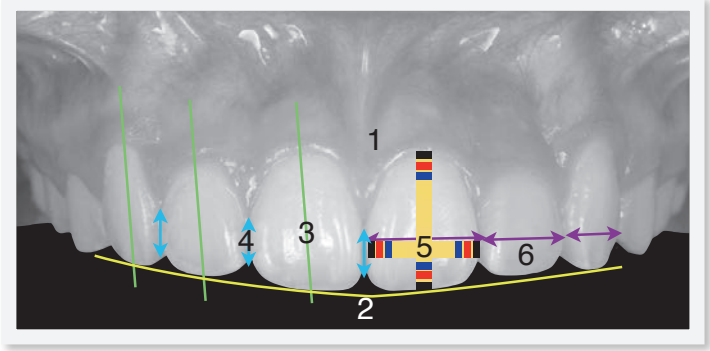
Total = 1

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 = 1



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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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)

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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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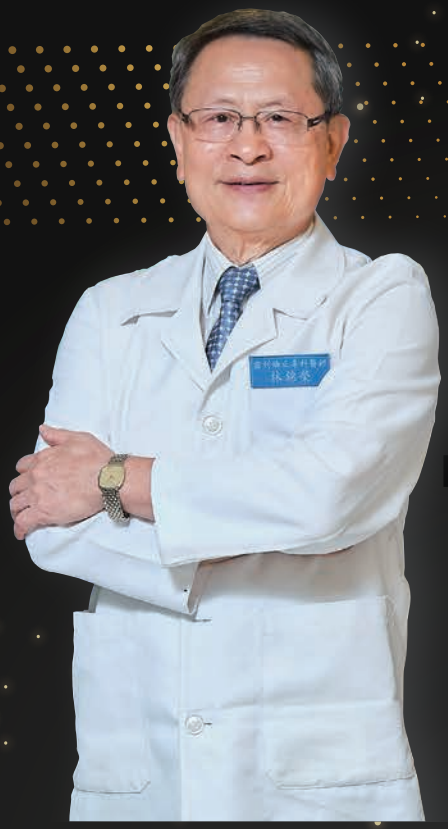

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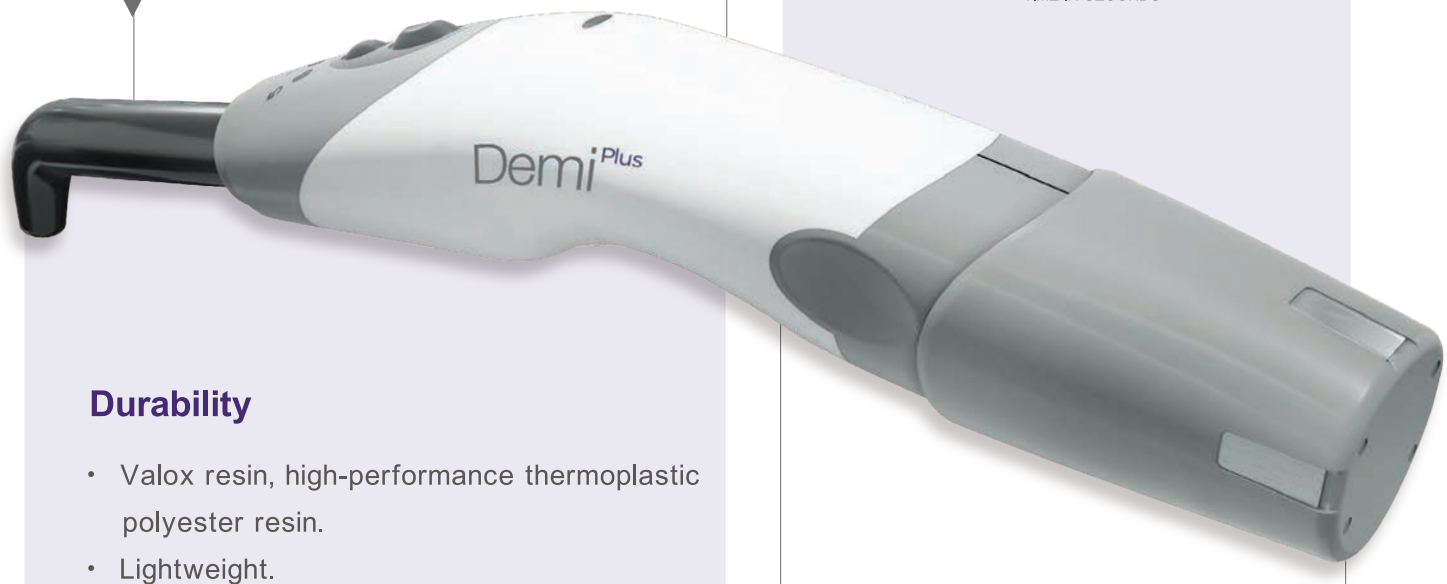

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Class III Camouflage Treatment: Premolar Extractions, Bite Turbos, and Differential Space Closure

Abstract

***History**: A 24 year-old male presented with protruded chin, crowded dentition, and poor smile esthetics. There was no contributing medical or dental history. Previous orthodontists recommended orthognathic surgery, but the patient preferred a more conservative approach.*

***Diagnosis**: Skeletal Class III malocclusion (SNA 89˚, SNB 86˚, ANB -3˚) was complicated with bimaxillary protrusion, anterior crossbite and a concave profile. Asymmetric buccal segments were more Class III on the right side (8mm), and the mandibular midline was deviated 4mm to the left. The Discrepancy Index (DI) was 42 points.*

***Treatment**: Four 1st premolars were extracted to provide space for camouflage treatment. Class III elastics and an inclined bite plane on the lower incisors were used to correct the anterior crossbite. The buccal segment asymmetry and crowding were resolved with differential space closure and Class III elastics in all four quadrants. Posterior crossbite tendency was controlled with cross-elastics and upper archwire expansion.*

***Results**: Retraction of the lower anterior segment improved facial convexity from 0˚ to 2˚. After 30 months of active treatment, this severe skeletal malocclusion was corrected to an excellent Cast-Radiograph Evaluation (CRE) of 26 points and a Pink & White dental esthetic score of 5.*

***Conclusions**: Severe Class III skeletal malocclusion can be resolved with extractions and camouflage treatment. Mandibular buccal shelf bone screw anchorage may improve incisal angulation. (J Digital Orthod 2020;60:40-55)*

Key words:
Class III malocclusion, non-surgical treatment, anterior crossbite, bite turbos, torque selection

Introduction

Class III malocclusion is challenging particularly when there are asymmetric skeletal components. For non-growing adults, camouflage treatment rather than orthognathic surgery has long been debated.[1] If the patient desires a skeletal correction, orthognathic surgery is necessary. However, the expense and surgical morbidity are unattractive aspects, so camouflage treatment was developed to achieve an acceptable, compromised outcome.[2] Non-extraction camouflage treatment can be accomplished with Class III elastics if the malocclusion is symmetric, and it is acceptable to open the vertical dimension of occlusion. However, in the presence of substantial crowding and intermaxillary asymmetry, extraction in all four quadrants is preferable because it provides space for differential space closure. Class III camouflage treatment with extractions can improve the ANB angle and decrease facial convexity with little or no change in the vertical dimension of occlusion (*facial height*).[3-8] With careful selection and diagnosis, 92% of adult Class III malocclusion patients can be effectively treated with orthodontic therapy alone.[1]

Bear Chen,
Lecturer, Beethoven Orthodontic Course (Left)
Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center)
W. Eugene Roberts,
Editor-in-Chief, Journal of Digital Orthodontics (Right)

This case report documents the conservative management of an adult skeletal Class III malocclusion complicated with anterior crossbite, asymmetric molar relationship, and midline deviation (*Figs. 1-5*). Conservative treatment (*Figs. 6-8*) resulted in an acceptable camouflage result (*Figs. 9-12*).

Fig. 1: Pre-treatment facial and intraoral photographs. See text for details.

Fig. 2:
The facial profile and frontal intraoral views are compared in centric occlusion (C_O) and centric relation (C_R). In the C_R position, the incisors are in an end-to-end relationship, and the facial profile is acceptable.

The dental nomenclature for this report is a modified Palmer notation with four oral quadrants: upper right (*UR*), upper left (*UL*), lower right (*LR*), and lower left (*LL*). From the midline, the permanent teeth are numbered 1-8, e.g., a lower right first molar is LR6.

Diagnosis and Etiology

A 24-yr-5-mo-old male presented for orthodontic consultation with the following chief concerns: protruded chin, crowded dentition, and poor smile esthetics (*Figs. 1-5*). There was no contributing medical or dental history. The clinical examination showed a protrusive lower lip, an anterior crossbite from UR2 to UL3, and distally tipped lower incisors (*Fig. 5, Table 1*). The overjet was -5mm, and the overbite was 2mm. Crowding was severe (*15mm*) in the maxillary arch, but it was only moderate (*5mm*) in the mandibular arch. The molar relationship was asymmetrical full-cusp Class III (*right side*) and end-on Class III (*left side*) (*Fig. 4*). Lin's 3-Ring Diagnosis (*Fig. 13*) revealed (*1*) an orthognathic profile, (*2*) 3mm anterior functional shift, and (*3*) near Class I buccal relationships in C_R (*Figs. 2 and 5, Table 1*). The panoramic radiograph showed asymmetrical temporomandibular joints but no specific intraoral dental problems (*Fig. 3*). Cephalometric analysis (*Table 1*) documented an ANB angle of -3˚ and protruded lower lip (*7mm to the E-Line*). A careful evaluation of

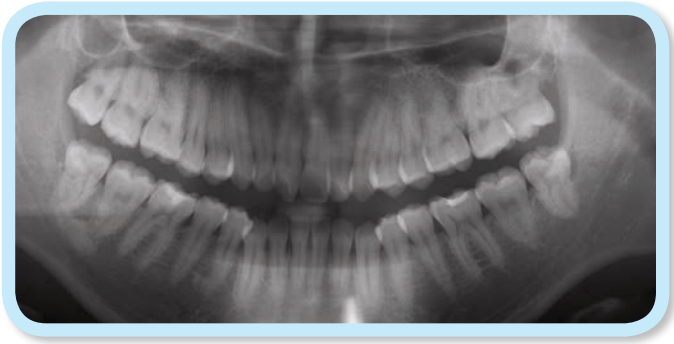

Fig. 3: Pre-treatment panoramic radiograph

Fig. 4:
Pre-treatment study casts show a full cusp Class III molar relationship on the right side, but the left side is only a half cusp Class III. Distally inclined lower incisors and an anterior crossbite complicate the malocclusion. See text for details.

Fig. 5:
Pre-treatment cephalometric radiograph shows the anterior crossbite. See text for details.

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	86°	85.5°	0.5°
SNB° (80°)	89°	87°	2°
ANB° (2°)	-3°	-1.5°	1.5°
SN-MP° (32°)	36°	37°	1°
FMA° (25°)	28°	29°	1°
DENTAL ANALYSIS			
U1 To NA mm (4mm)	8	7	1
U1 To SN° (104°)	123°	116°	7°
L1 To NB mm (4mm)	5.5	2	3.5
L1 To MP° (90°)	78°	75°	3°
FACIAL ANALYSIS			
E-LINE UL (-1mm)	-0.5	-1	0.5
E-LINE LL (0mm)	7	1	6
%FH: Na-ANS-Gn (53%)	53%	55%	2%
Convexity: G-Sn-Pg' (13°)	0°	2°	2°

Table 1: Cephalometric summary

the Discrepancy Index (*DI=42*) (*Worksheet 1*) and Lin's 3-Ring Diagnosis (*Fig. 13*) indicated conservative treatment was feasible, but Chang's extraction decision chart (*Table 2*) indicated that extractions were needed to manage the asymmetry, protrusion, and crowding.

Treatment Objectives

The treatment objectives were: (*1*) correct the anterior crossbite; (*2*) relieve the crowding of the upper anterior teeth; (*3*) retract the lower lip; (*4*) create ideal overbite and overjet; and (*5*) establish functional Class I molar and canine relationships.

Treatment Plan

Extract all four first premolars to relieve the crowding while maintaining the position of the upper lip.

Correct the anterior crossbite with an inclined bite plate on the lower anterior segment and Class III elastics. Install 2x12-mm OrthoBoneScrews (*OBS®s*) (*iNewton, Inc., Hsinchu, Taiwan*) in the mandibular buccal shelves if supplemental anchorage is required. Because of extensive Class III elastic mechanics, bracket requirements for the anterior segments are low torque in the upper, and high torque in the lower arches (*Figs. 14, 16, and 18*).

Treatment Alternatives

The preferred orthognathic surgical options were Le Fort I with bilateral intraoral vertical ramus osteotomies. The patient declined surgery because of the hospitalization, high cost, and risk of complications.

Treatment Progress

A 0.022-in slot Damon Q® fixed appliance (*Ormco, Brea, CA, USA*) with passive self-ligating (*PSL*) brackets was selected. After the 1st premolars were extracted, the lower arch was bonded with super

Fig. 7:
The negative overjet decreased from -5mm at the start of treatment (0M) to -1.5mm at eight months (8M). At 13 months (13M), the anterior inclined bite plate was bonded on the lower incisors as shown in the buccal (left) and frontal (right) views.

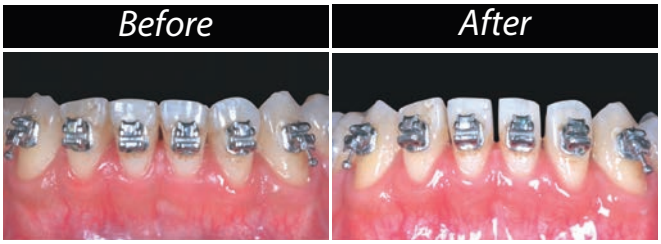

Fig. 8:
The IPR procedure is shown before and after the incisors were reshaped to eliminate black interproximal spaces, increase contact area, and provide space to retract the anterior segment.

Fig. 6:
At two months (2M), open coil springs and elastomeric chains are applied to help relieve crowding. By the 5th month, a 0.014-in CuNiTi wire is engaged in all of the upper brackets. In the 8th month of treatment, crowding is relieved, anterior alignment is improved, and most of the extraction space is closed. See text for details.

high torque brackets in the anterior segment (*Fig. 14*). Two months later, the upper arch was bonded with standard torque brackets. To prevent binding and notching of the archwire in the UR1, UR2, and UL2 brackets,[15] open coil springs (*nickel-titanium springs*) were placed on the archwire to open space (*Fig. 6, left*). The initial archwire was 0.014-in copper-nickel-titanium archwire. Class III early light short elastics (*Parrot, 5/16-in, 2-oz; Ormco, Brea, CA, USA*) were placed from the mandibular second premolars to the maxillary 1st molars. In addition, a five-ring power-chain was placed bilaterally from the maxillary canines to the maxillary 1st molars to close the extraction spaces and relieve the anterior crowding. By the 5th month of treatment, the open coil springs were removed, and the mandibular archwire was changed to 0.014x0.025-in copper-nickel-titanium (*Fig. 6*). In the 8th month, the crowding was nearly resolved. In the 13th month, the upper and lower archwires were both changed to 0.016x0.025-in SS. The overjet decreased from -5mm to -1.5mm, and the extraction spaces in the upper arch were decreased. An anteriorly inclined bite plate was bonded from tooth LL2 to LR2 to

Fig. 9: Post-treatment facial and intraoral photographs

correct the anterior crossbite (*Fig. 7*). Class III elastics (*Fox, 1/4-in, 3.5-oz; Ormco, Brea, CA, USA*) and five-ring power-chains were used to retract the lower anterior teeth. After four months with the bite plate, the anterior crossbite was corrected. In the 26th month, interproximal reduction was performed in the lower anterior segment to reduce dark triangles (*Fig. 8*). Final space closure and detailing were accomplished. After 30 months of active treatment, all appliances were removed.

Treatment Result

Correction of the anterior crossbite and retraction of the lower lip significantly improved the facial profile (*Fig. 9*). Both arches were well aligned and optimally interdigitated, resulting in a near ideal Class I occlusion with coincident midlines (*Fig. 10*). Panoramic radiography revealed good axial alignment of the dentition (*Fig. 11*). Cephalometric superimpositions revealed mandibular incisors were retracted about 7mm, and axial inclinations were acceptable (*Fig. 12*). These outcomes indicated the effect of space closure was well compensated by the high-torque brackets and the reverse Curve of Spee in the archwire (*Fig. 12*). Maxillary incisors were maintained in the original anterior-posterior (*A-P*) plane, and their axial inclination was improved (*U1-SN: 123° to 116°*). This was not an ideal outcome, but it was acceptable for the camouflage correction of a severe skeletal Class III malocclusion. The mandible was rotated clockwise (*posteriorly*) because of the lower molar extrusion due to Class III elastics. The protrusive lower lip was corrected by retracting the lower incisors (*Fig. 12*).

The Cast Radiograph Evaluation (*CRE*) score was 26 points, as shown in the supplementary Worksheet 2. The major residual discrepancies were the buccolingual inclination (*7 points*). Dental esthetics were acceptable as documented by a Pink and White esthetic score of 5, as shown in Worksheet 3. This conservative treatment plan required ~2.5 years (*30 mo*) of active treatment. The patient was pleased with the dental and facial outcomes.

Fig. 10: Post-treatment study models (casts)

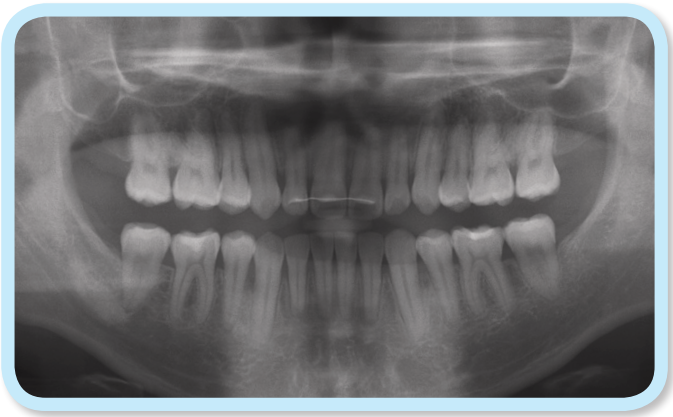

Fig. 11: Post-treatment panoramic radiograph

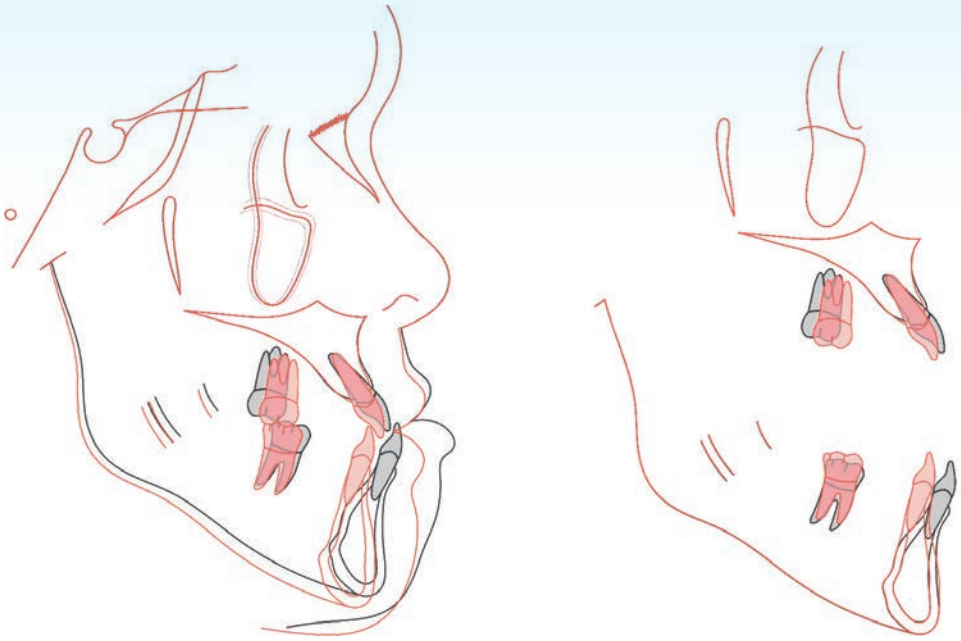

Fig. 12:
Superimposed cephalometric tracings (pre-Tx: black; post-Tx: red) indicate that the mandible rotated clockwise, which contributed to the retraction of the lower lip (left). In the maxillary arch (upper right), incisors were also retracted. Lower incisors were bodily retracted to correct the anterior crossbite (lower right). See text for details.

The four-year follow-up record (*Fig. 19*) shows stable occlusion and pleasant esthetics. The periodontal state is healthy and shows no gingival recession at all. The posterior openbite is resolved by itself. No signs of relapse are noted, and no symptoms of TMD are present.

Discussion

The specific indication for orthognathic surgery is a malocclusion with skeletal or dentoalveolar anomalies that cannot be adequately corrected with tooth movement alone.[12] The American Association of Oral and Maxillofacial Surgeons recommends orthognathic surgery if horizontal overjet is zero or negative, and the A-P molar discrepancy is >4mm Class III. The present patient is clearly in the zone for orthognathic correction because overjet was -4mm and molar discrepancy was 5mm. However, a substantial functional shift may accentuate a dental discrepancy, e.g., anterior crossbite.[13] Non-surgical treatment may be feasible by correcting the shift and increasing the lower facial height. The 3-Ring Diagnosis developed by Lin is particularly helpful for treatment planning of marginal Class III malocclusions (*Fig. 13*).[16,18] There are three favorable indicators for the present patient when he was positioned in centric relation: an orthognathic profile (*acceptable facial balance*), buccal segments near Class I, and an A-P functional shift of ~3mm into maximal intercuspation.

Class III camouflage treatment may result in increased axial inclination of the maxillary incisors and decreased axial inclination of the mandibular incisors, particularly if there is an underlying Class III skeletal discrepancy.[16,17,18,25] Low-torque brackets are usually recommended for the upper incisors, but standard torque brackets were used even though the inclination of the upper incisors was 123˚ to the SN plane (*Table 1*). This flexibility reflects extractions to provide the space needed to correct 15mm of anterior crowding; then little A-P movement of the upper incisors is required. When lingually-tipped lower incisors (*L1-MP: 78˚*) are retracted, two methods can be used to increase incisal torque: (*1*) turn the low-torque brackets upside down to produce high-torque effects[19,21,25] (*Fig. 14*); and (*2*) place a pre-torqued archwire such as 0.016x0.025-in or 0.019x0.025-in NiTi.[18,25,26] When comparing the pre-treatment and post-treatment cephalometric measurements (*Table 1, Fig. 12*), lower incisor torque was managed effectively. According to the decision table formulated by Chang (*Table 2*), extractions were needed to efficiently relieve the upper arch crowding while maintaining the nasolabial angle. In the lower arch, extraction of the mandibular 1st premolars was helpful to (*1*) provide space for lower incisor retraction; and (*2*) prevent the distal angulation of the terminal molar compared to retraction of the entire lower arch.

The protocol for bite turbos (*glass ionomer cement occlusal bite raisers*) was necessary for correction of the anterior crossbite[20,25] because they: (*1*) prevent premature occlusal contact on brackets, (*2*) control wear on the teeth particularly with parafunction, (*3*) facilitate arch development, and (*4*) create interocclusal space for the crossbite correction. Bite turbos can be placed in the anterior or posterior

Profile: Orthognathic profile at C_R position
Class: Canine and molar Class I relationship
FS: Functional shift ($C_O \neq C_R$)

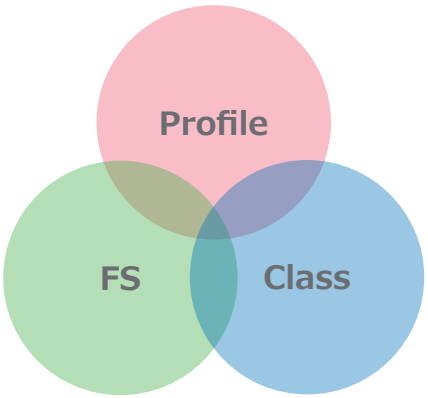

Fig. 13:
The Class III diagnostic system of Lin evaluates the facial profile and molar classification in C_R, as well as any functional shift from C_R to C_O. If the profile is acceptable in C_R, the molars are in or near Class I, and there is a significant functional shift, the patient can usually be managed effectively with conservative camouflage treatment.

Fig. 14:
Reversing a low torque bracket (-11˚) results in a high-torque bracket (+11˚). See text for details.

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

Table 2:
Chang's extraction decision chart suggests removing premolars because of a protrusive facial profile and crowding >7mm.

segments of either arch. There are some limitations for bite turbo applications, e.g., it is best to avoid: (*1*) weak teeth, such as upper lateral incisors, endodontically treated teeth, and/or periodontally compromised dentition, (*2*) teeth with large restorations or temporary crowns, (*3*) isolated teeth subject to high stress, and (*4*) target teeth that are to be moved. When the occlusion is discluded, make sure the bite opening is bilateral and comfortable for the patient. For the present patient, it was necessary to level and align multiple teeth, so the bite turbos were on the second molars (*Fig. 15*). Opening the bite accelerated the initial stage of the orthodontic treatment. By the 13th month, all the teeth were provisionally aligned, and the anterior inclined bite plane[10] (*glass ionomer resin*) was constructed (*Fig. 16*). Four months were required to correct the anterior crossbite with the inclined plane and Class III elastics.

When correcting a Class III malocclusion, lingual posterior crossbite is a common complication associated with lower arch retraction. There are several strategies to manage posterior crossbite tendency: (*1*) use lighter force to close posterior space; (*2*) bond buttons on the lingual so space closure mechanics can be applied simultaneously on the buccal and lingual surfaces; and (*3*) design archwire compensation. For the present patient, posterior crossbite was first noted 26 months into treatment. The upper archwire was expanded in the posterior, and crossbite elastics were applied (*Fig. 17*).

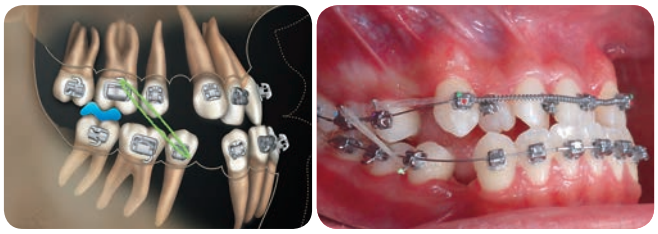

Fig. 15:
Posterior bite-turbos (blue) opened the bite to prevent incisal bracket prematurities in occlusion. Early light short Class III elastics (green) were worn from U6 to L5.

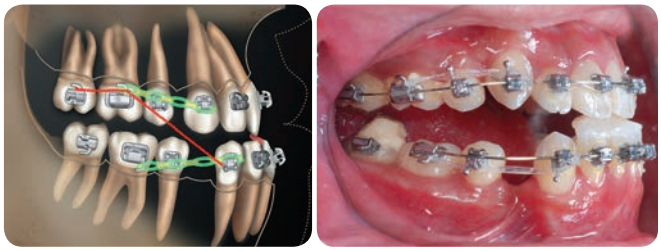

Fig. 16:
Left: *Thirteen months into treatment, the mechanics were space closure with chains of elastics (green) and Class III elastics (red).*
Right: *An anteriorly inclined bite plate was constructed with glass ionomer cement on the lower incisors to help correct the anterior crossbite. The lower archwire was cut distal to the lower first molars to decrease the friction for sliding space closure mechanics.*

The lower Curve of Spee (*CoS*) was increased by the occlusal moment produced by the elastic chains used for differential space closure to correct the Class III buccal segments (*Fig. 18*). This is a common problem when closing extraction spaces even if the dentition is well aligned. Beginning at 13 months, a reverse curve in the lower archwire corrected the CoS. By the 20th month, the CoS was again increased as the lower incisors tipped lingually (*Fig. 18*). Another reverse CoS in the archwire compensated for this unwanted side effect. By the 24th month into treatment, the CoS problem was resolved.

Conclusions

A severe skeletal malocclusion was treated to an acceptable outcome without orthognathic surgery. Differential diagnosis utilizing Lin's 3-Ring Diagnosis and Chang's extraction decision table helped formulate an effective yet conservative treatment plan. Thirty months of carefully-sequenced treatment achieved an acceptable result.

In retrospect, mandibular buccal-shelf bone screws may have decreased treatment time and improved axial inclination of the incisors.

Fig. 19 documents the current condition of the patient 4 years post-treatment.

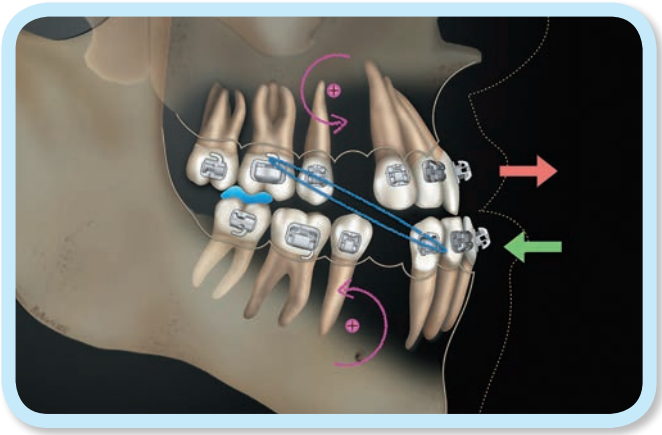

Fig. 18:
Class III elastics (blue) rotate each arch around a center of resistance as depicted by magenta curved arrows and dots with a cross in the center. These mechanics tip the upper anterior segment labially (pink arrow), and the lower anterior segment lingually (green arrow). See text for details.

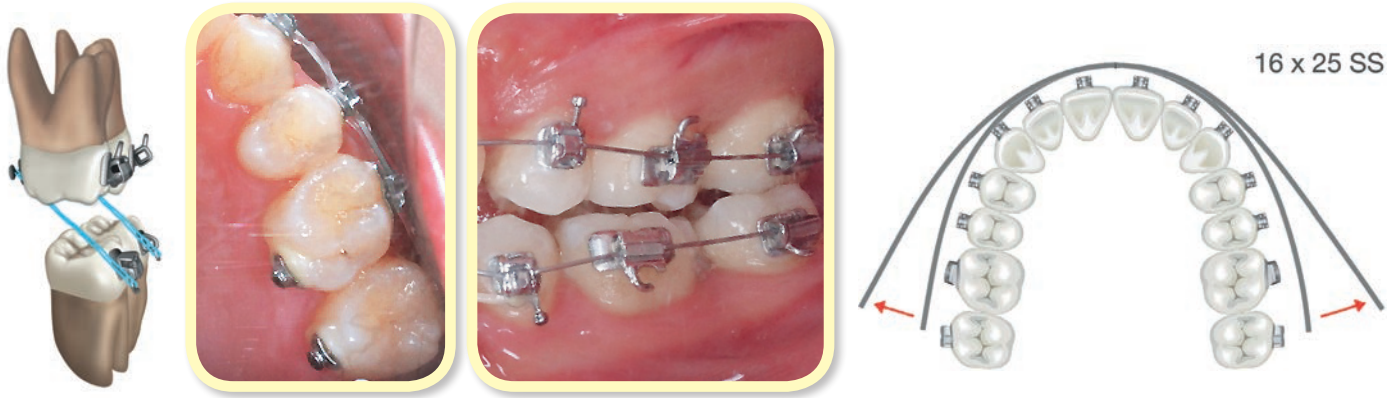

Fig. 17:
In the 27th month of treatment, a posterior crossbite tendency was noted for the UL6 and UL7. Buttons were bonded on the palatal surfaces of the affected molars and 3.5oz crossbite elastics were applied (left). In addition, the upper 0.016x0.025-in stainless steel archwire was expanded (red arrows on the right).

Acknowledgments

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Fig. 19: Facial and intraoral photographs at 4-year follow-up

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 42

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 = 19

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 = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

1 – 3 mm.	=	1 pt.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	4 pts.
> 7 mm.	=	7 pts.

Total = 7

OCCLUSION

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

Total = 6

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. = 1

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 = 5

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. =	3
Addl. treatment complexities	_____ x 2 pts. =	

Identify:

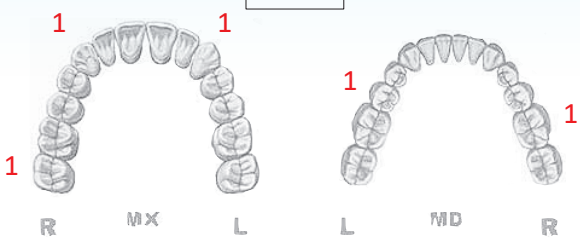
Total = 5

Cast-Radiograph Evaluation

Total Score: 26

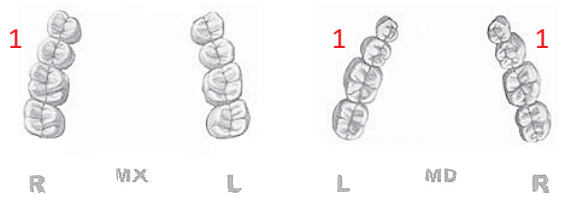
Alignment/Rotations

5



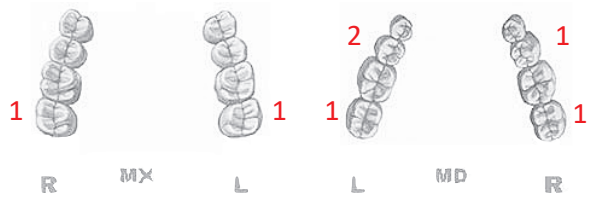
Marginal Ridges

3



Buccolingual Inclination

7

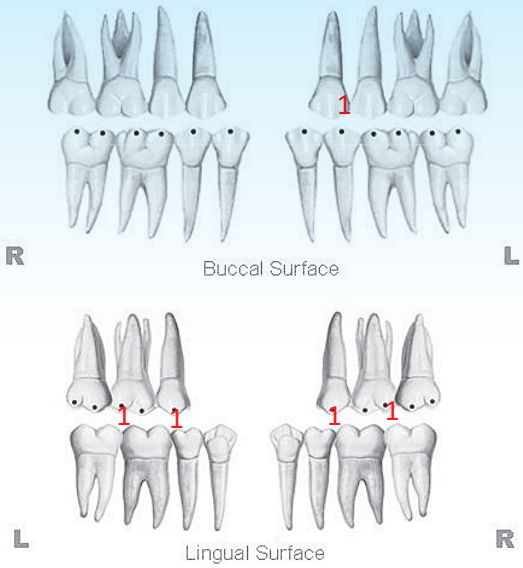


Overjet

6

Occlusal Contacts

5



Occlusal Relationships

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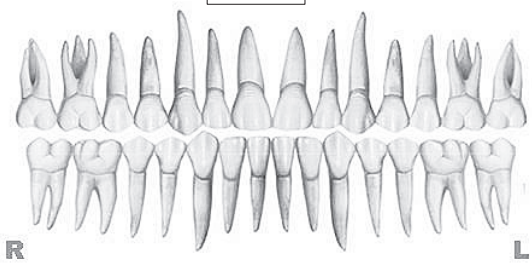
Interproximal Contacts

0



Root Angulation

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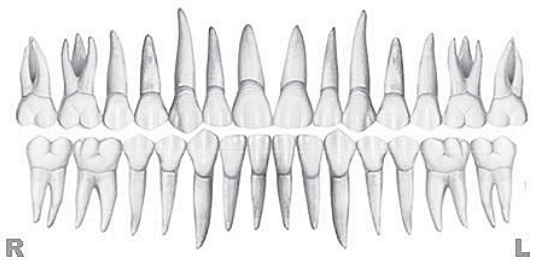


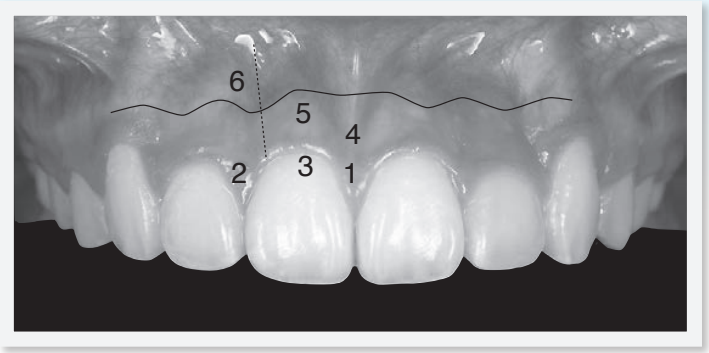
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

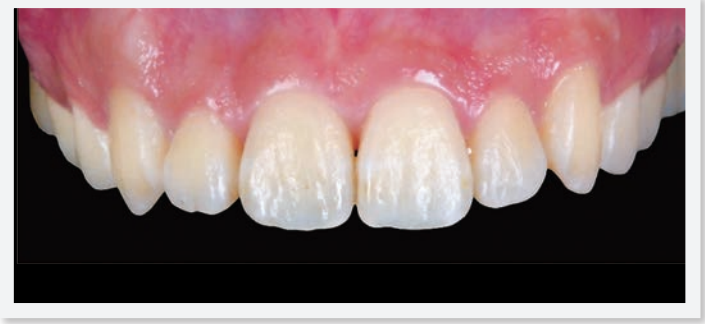
Total Score: = 5

1. Pink Esthetic Score

Total = 2



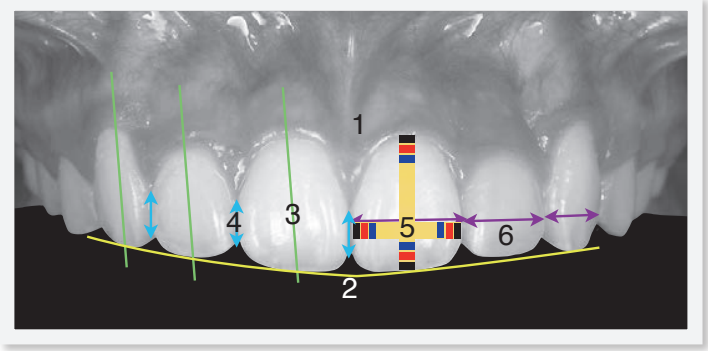
1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2



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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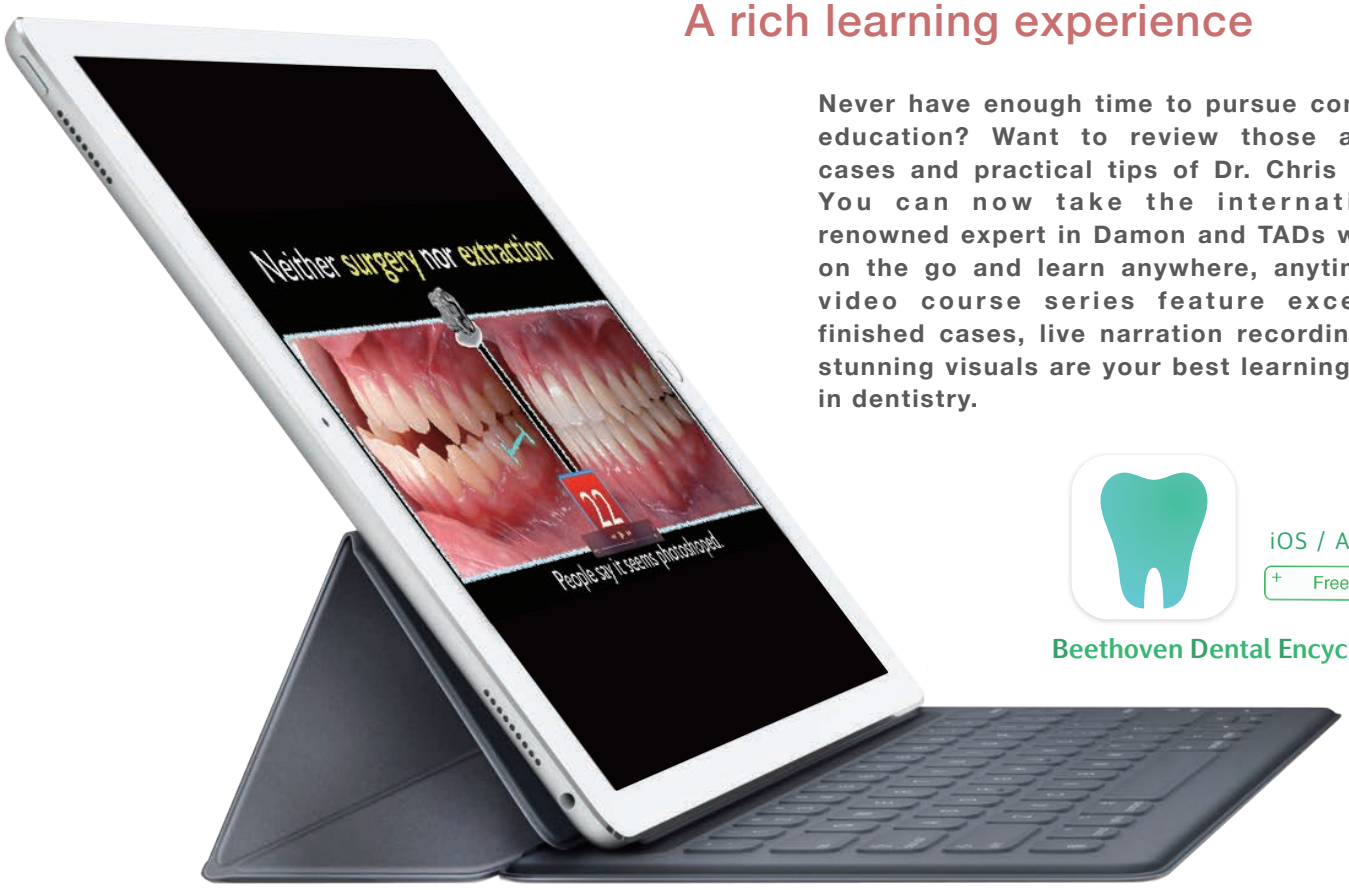

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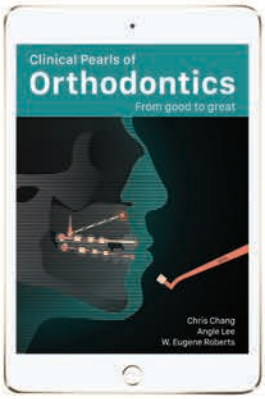

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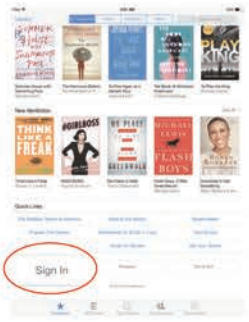

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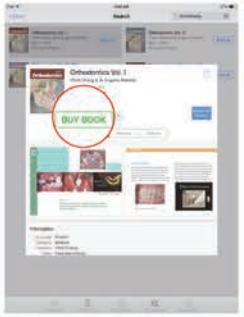

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	Session B	10/07–10	10/11

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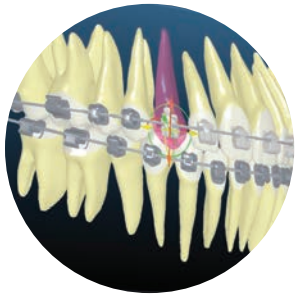

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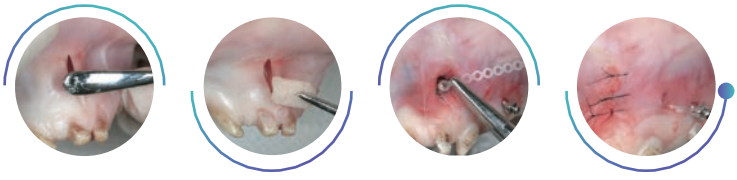

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Course Schedule

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
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Digital Orthodontics, OBS & VISTA

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by Newton's A team

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3. Basic animations and visual aids

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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.

Bimaxillary Protrusion and Gummy Smile Treated with Clear Aligners: Closing Premolar Extraction Spaces with Bone Screw Anchorage

Abstract

Inadequate posterior anchorage is a serious limitation for aligner treatment involving extraction of four first premolars. Inappropriate axial inclinations may compromise intermaxillary occlusion and stability. OrthoBoneScrew (OBS®) anchorage is designed to augment the Invisalign® clear aligner G6 solution to produce more predictable outcomes as illustrated by the current case report. An 18-year-old female presented with two chief complains: (1) protrusive, incompetent lips, and (2) excessive gingival exposure when smiling ("gummy smile"). Clinical evaluation revealed bimaxillary protrusion, hypermentalis activity, anterior crowding, and excessive anterior axial inclinations, particularly of the lower incisors (116˚). The American Board of Orthodontics (ABO) Discrepancy Index (DI) was 21. The treatment plan was extraction of all four first premolars, and clear aligner (Invisalign®) therapy anchored with four OBS®s: infrazygomatic crest (IZC), and between the roots of the upper central and lateral incisors (Incisal) bilaterally. Eighteen months of initial treatment with 45 aligners retracted and intruded the anterior segments in both arches by closing the extraction spaces with supplemental anchorage provided by IZC and Incisal OBS®s. The final series of 20 refinement aligners achieved an excellent outcome as evidenced by an ABO Cast-Radiograph Evaluation (CRE) score of 10, and a pink and white (P&W) dental esthetic score of 3. Post-treatment analysis revealed multiple opportunities for improvement. The patient was well satisfied with the final outcome. (Reprinted with permission from APOS Trends Orthod 2020;10(2):120-31). (J Digital Orthod 2020;60:62-79)

Key words:

Bimaxillary protrusion, gummy smile, premolar extraction, clear aligner treatment, Invisalign G6, IZC, Incisal, bone screws, space closure, anchorage, torque control

Introduction

Modern aligner therapy has expanded the treatment perspective for managing complex malocclusions with removable appliances. The Invisalign® system (*Align Technology, Inc., San Jose, CA, USA*) is a leader in the applied technology. Over the years, clinical opinions of aligner therapy have progressed from doubtful[1] to reserved,[2] and they are now progressing to an evolving consensus that aligner therapy is an efficient solution for mild-to-moderate malocclusions.[3] Although some complex malocclusions have been treated with aligners,[4,5] the results are less accurate and predictable than treatment with fixed appliances.[6]

One of the more challenging clinical scenarios for aligners is the treatment of extraction cases. In particular, root paralleling after space closure is inconsistent.[7] Tipped teeth can be corrected with fixed appliances, but sequential treatment with two modalities may require more treatment time than with fixed appliances alone.[8,9]

Lexie Y. Lin,
Lecturer, Beethoven Orthodontic Course (Left)
Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center)
W. Eugene Roberts,
Editor-in-Chief, Journal of Digital Orthodontics (Right)

To improve clinical outcomes particularly for extraction of first premolars, Align Technology released the G6 protocol along with SmartStage® in 2015.[10] The principle of differential moments (*couples produced with coordinated sets of attachments*) is used for Invisalign® G6 to provide anterior retraction with maximum posterior anchorage.[11] SmartStage® is engineered to optimize the progression of tooth movement based on algorithms developed with a massive data base, i.e., artificial intelligence (*AI*).[12] The force system for G6 is indeterminate mechanics which are not intuitive. If a clinician accepts the G6 protocol with optimized attachments, the treatment plan cannot be changed.

The successful completion of treatment with the G6 protocol is followed at chairside.[13] However, a recent study conducted by Peking University reported that G6 showed molar anchorage loss that was similar to conventional attachments.[14] The retraction of incisors was less than predicted, and there were multiple side effects such as lingual tipping and extrusion.[14] The difference between the ClinCheck® prediction and the actual outcome was similar to loss of torque with fixed appliances due to the play between archwires and brackets slots.[15]

Clinicians who prescribe Invisalign® treatment still have much to learn regarding the biomechanics and efficacy of the system.[2] Clear aligner treatment can be enhanced with auxiliaries designed to improve the predictability of outcomes.[16] The aim for the present case report is to demonstrate the potential for OrthoBoneScrews (*OBS®s*) (*iNewton, Inc., Hsinchu City, Taiwan*) in supplementing anchorage. The authors feel this approach may evolve to be the "*gold standard*" for patients who demand inconspicuous aligner therapy for demanding malocclusions requiring extractions in all four quadrants.

The dental nomenclature for this report is the modified Palmer notation. Upper (*U*) and lower (*L*) arches, as well as the right (*R*) and left (*L*) sides, define the four oral quadrants: UR, UL, LR, and LL. Teeth are numbered 1-8 from the midline in each quadrant, e.g., a lower right first molar is LR6.

Diagnosis

An 18-year-old female presented with chief complaints of protrusive lips and a gummy smile tendency, which affected her confidence and productivity. The patient had no significant medical or dental history. Oral hygiene was acceptable, and her motivation for treatment was to improve smile esthetics with clear aligner treatment.

Pretreatment facial photographs showed balanced facial proportions. A functional exam documented lip incompetence with hyperactive mentalis muscles

to achieve lip closure (*Fig. 1*). Analysis of the pre-treatment diagnostic records revealed Class I molar and Class II canine relationships bilaterally (*Fig. 1*). Bimaxillary protrusion with an 5mm overjet and 2mm overbite was associated with ~3mm of crowding in the upper arch and an anterior Bolton ratio of 75.9%. The maxillary and mandibular midlines were deviated by 0.5mm and 1.5mm to the right, respectively. The panoramic radiograph showed four unerupted third molars, and cephalometric analysis revealed a normal skeletal relationship with flared incisors (*Fig. 2, Table 1*). The ABO Discrepancy Index (*DI*) was 21 as shown in the subsequent Worksheet 1.

Treatment Objectives

The treatment objectives were to: (*1*) reduce dental protrusion by improving lip profile; (*2*) achieve normal overjet and overbite; (*3*) maintain a bilateral Class I molar relationship; (*4*) obtain a bilateral Class I canine relationship; (*5*) coordinate midlines; and (*6*) align arches.

Fig. 1: Pretreatment extraoral and intraoral photographs

Fig. 2: Pretreatment panoramic radiograph (left) and lateral cephalometric radiograph (right)

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	83.5°	83.5°	0°
SNB° (80°)	80.5°	81.5°	1°
ANB° (2°)	3°	2°	1°
SN-MP° (32°)	27.5°	26.5°	1°
FMA° (25°)	20.5°	19.5°	1°
DENTAL ANALYSIS			
U1 To NA mm (4mm)	10	3.5	6.5
U1 To SN° (104°)	118°	107°	11°
L1 To NB mm (4mm)	9.5	4	5.5
L1 To MP° (90°)	115°	96°	19°
FACIAL ANALYSIS			
E-LINE UL (-1mm)	1	-2	3
E-LINE LL (0mm)	3	-2	5
%FH: Na-ANS-Gn (53%)	56%	55%	1%
Convexity: G-Sn-Pg' (13°)	15°	11°	4°

Table 1: Pre-treatment and post-treatment cephalometric analysis

Treatment Alternatives

The focus of Invisalign® aligner treatment was correction of the lip protrusion and gummy smile (*Fig. 3*). A non-extraction treatment approach was considered: arch retraction of 3mm in every quadrant, interproximal reduction (*IPR*) to relieve crowding, and rounding-out the arch form.[17] Extraction of all the third molars was discussed

Fig. 3:
Pretreatment extraoral photograph revealed patient's gummy smile tendency. Note that the width of exposed gingiva is 4mm superior to the U2s.

because it would aid with arch retraction, but the patient declined the projected result for non-extraction treatment because it failed to adequately reduce dental protrusion and mentalis strain. The alternative treatment option was extraction of four first premolars, followed by Invisalign® treatment supplemented with OBS® anchorage to retract and intrude the incisors. The patient accepted the extraction treatment plan which involved: (*1*) two 2x12-mm OBS®s installed bilaterally in the infra-zygomatic crest (*IZC*), (*2*) two additional 1.5x8-mm Incisal OBS®s in the maxillary anterior inter-radicular (*I-R*) region between central and lateral incisors bilaterally, (*3*) elastics (*Ormco Corporation, Brea, CA*) hooked on the bone screws to retract and intrude the maxillary anterior segment, and (*4*) IPR to address a Bolton discrepancy between the arches.

Treatment Progress

iTero Element® intraoral scans (*Align Technology, Inc., San Jose, CA, USA*) provided a 3D dataset.[18] The ClinCheck® (*Align Technology, Inc., San Jose, CA, USA*) system was used to plan the treatment and project the outcome. Both optimized and conventional attachments were applied in sequential staging (*Fig. 4*). The treatment was conducted in two phases: initial and refinement. Oral hygiene and aligner fit were monitored at monthly intervals.

Initial Phase

The major goals of the initial treatment were to retract the anterior segments as the arches were intruded (*Fig. 5*). A total of 45 sets of aligners were used over 13 months. According to the clinician's

Fig. 4:
ClinCheck® treatment plan and prescribed attachments are shown for the initial phase of treatment. Blue dots indicate variably predictable tooth movement (2.5-3mm intrusion for lower incisors; 4-6mm root movement for LR5). Black dots indicate less predictable tooth movement (>3mm intrusion for upper incisors; >6mm root movement for UR3). See text for details.

instructions, the first set of 38 aligners were changed every 10 days, and then every 7 days for the last 7 aligners. Optimized root control attachments were used on canines in combination with precision cuts. Optimized anchorage attachments were provided for the posterior teeth (*Fig. 6*). Half pontics were used for esthetic replacement of missing teeth. SmartStage® technology was used for the upper incisors to minimize unwanted tipping and anterior extrusion.[12]

Fig. 5:
ClinCheck® initial phase treatment is projected by superimposition (blue: original tooth position; white: simulation of final tooth position) on dental landmarks that are programmed to be stable. Maximum anchorage is planned in the upper arch, consistent with more moderate anchorage for the lower arch. The anchorage requirements in both arches are quite challenging, and require TAD anchorage.

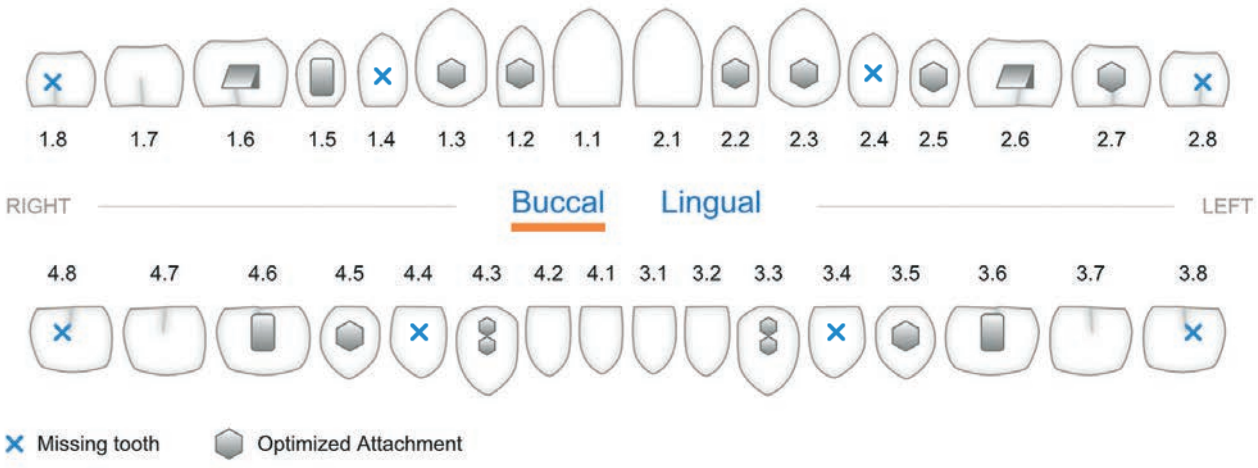

Fig. 6:
The initial phase of Invisalign® treatment utilizes SmartForce® features (optimized attachments in hexagon) for the Invisalign G6 solution to provide maximal posterior anchorage for distal translation of canines. See text for details.

Anterior and IZC OBS®s were placed when the tenth aligner was delivered. Elastics (3.5oz) were worn full-time from the U3s to the IZC OBS® and from the anterior segment of the aligner to the Incisal OBS®s bilaterally (*Fig. 7*). Inwardly-inclined cuts were made chair side with dedicated cutting pliers for every aligner, and all elastics were preloaded. The patient was trained to hook the elastics intraorally from the OBS®s to the aligner cuts. An overlapping two-elastic design in the maxillary anterior avoided irritating the labial frenum. OBS® anchorage was essential for achieving the ClinCheck® simulations

Fig. 7:
Intraoral photographs show the mechanics after OBS® placement and the application of 3.5oz elastics for retraction of buccal segments and intrusion of the maxillary anterior segment.

Fig. 8:
A progressive series of left buccal intraoral photographs show the progress of treatment compared to ClinCheck® simulations: left 3 months,10/45 aligners; center 6 months, 21/45 aligners; right 10 months, 32/45 aligners. Note a modified G6 attachment is specified for the UL3 to accommodate a precision cut for an elastic anchored by the IZC OBS®. For the colored markings in the simulations, see Fig. 4 for details.

during treatment with the initial series of aligners (*Fig. 8*). The outcome at the conclusion of the initial phase of treatment was dependent on bone screw anchorage (*Fig. 9*).

Refinement Phase

Refinement (*finishing*) with 20 additional aligners was conducted to correct the Class II relationship on the right side by retracting the UR quadrant 1mm (*Fig. 10*). After all extraction spaces were closed, IPR was carried out to reduce black triangles and address the Bolton discrepancy (*Fig. 11*). In the finishing stage, the heavy occlusal contacts on posterior teeth were reduced. Subsequently, conventional attachments replaced the optimized attachments to provide predictable retention. Precision cuts were again prescribed for the finishing mechanics and retention. The patient continued to use all elastics bilaterally as prescribed.

Retention

Essix retainers (*Dentsply Sirona, Charlotte, NC, USA*) retainers were delivered for both arches. The patient was instructed to wear them full time for the first 6 months post-treatment and nights only thereafter.

Fig. 9:
Extraoral and intraoral photographs show the outcome for the initial phase of aligner treatment. A canine Class II window (interocclusal space) distal to the UR3 cusp is noted.

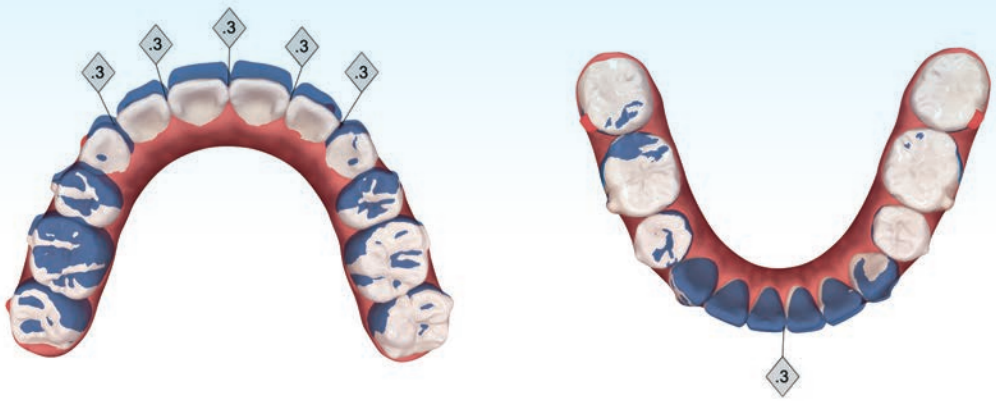

Fig. 10:
Refinement phase of treatment is programmed into ClinCheck® to retract the UR quadrant 1mm (blue: original tooth position; white: simulation of final tooth position). IPR of 0.3mm is planned for five sites in the maxillary anterior segment, but for only one site in the lower arch, to correct a perceived Bolton discrepancy.

Fig. 11:
Post-treatment extraoral and intraoral photographs. Gingivoplasty, as well as labial frenectomy, was performed with diode laser at the completion of the treatment. Note the buccal segments are slightly Class II, but there is no overjet, suggesting that more refinement of IPR was indicated in programming the refinement stage on ClinCheck®.

Instructions were provided for home care, as well as for maintenance of the retainers.

Treatment Results

This case report describes the correction of a malocclusion with a DI of 21, which was treated to an excellent CRE of 10 and a P&W esthetic score of 3, as shown in the subsequent worksheets (*Worksheets 2 and 3*). The total treatment duration was 18 months with a total of 65 aligners (*45+20*). Post-treatment records document achievement of all treatment objectives relative to good dental alignment and dentofacial esthetics (*Fig. 11*). Ideal overbite and overjet were achieved. Most importantly, all extraction spaces were closed with good maintenance of root parallelism (*axil inclination*) (*Fig. 12*). Upper and lower incisors were retracted and uprighted, improving the patient's lip profile and facial esthetics (*Table 1, Fig. 13*). The intrusion of the entire maxillary dentition corrected the gummy smile, and produced a slight counterclockwise rotation of the mandible to close the vertical dimension of occlusion. Buccal segments were corrected to Class I bilaterally. Upper and lower midlines were coincident with the facial midline. The patient was highly motivated and compliant with aligner wear and elastics. She was extremely happy with the treatment results. Overall, a near ideal outcome was achieved. Arrangements will be made in the future for third molar extractions.

Discussion

Extraction of four first premolars is often indicated for Asians to correct typically Class I malocclusions with bimaxillary protrusion with or without crowding.[19,20] Initial crowding may contribute to anchorage loss with fixed appliances[21] and aligners.[14] However, with the current Invisalign® approach, crowding is directly related to predictable tooth movement with aligners. Thus, the overall tooth movement, as well as mesial

Fig. 12:
Post-treatment panoramic radiograph (left) and lateral cephalometric radiograph (right). Good root parallelism is noted in the maxillary buccal segments, but all the teeth are more upright than normal (Fig. 3), which contributes to the Class II windows distal to the cusps of the U3s (Fig. 11).

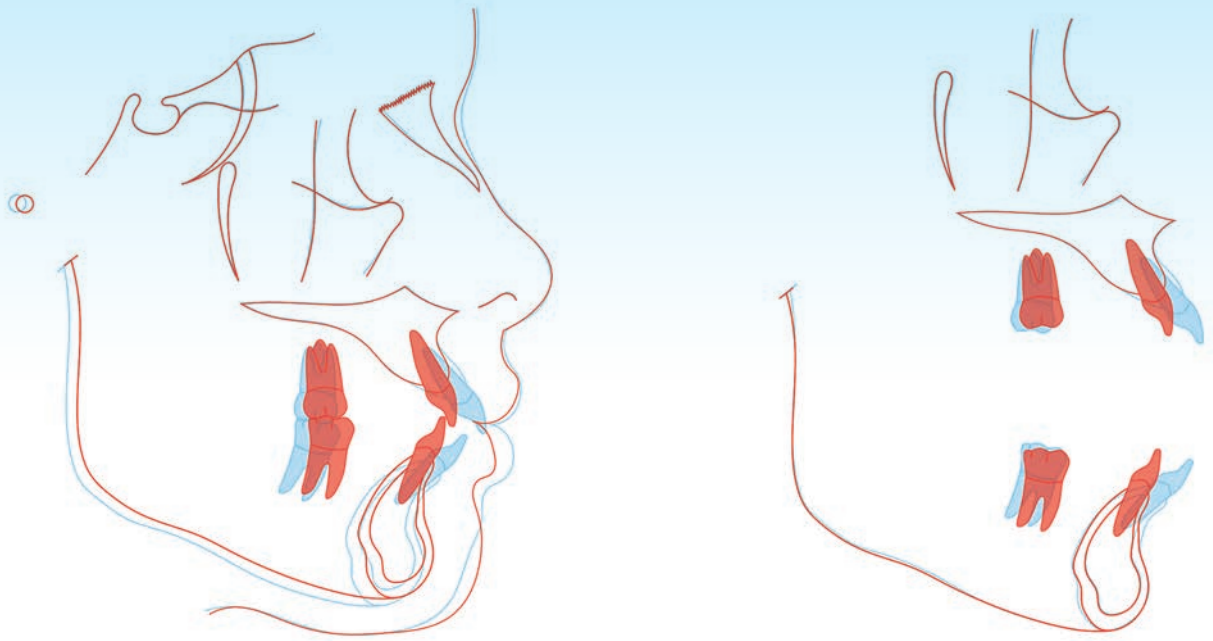

Fig. 13:
Superimposed tracings of the pre-treatment (blue) and post-treatment (red) lateral cephalometric radiographs show that bimaxillary protrusion was resolved dramatically (U1 and L1 retracted 6.5 and 5.5mm, respectively). The intrusion of entire upper dentition (U1 and U6 intruded 2.2 and 1.5mm, respectively) was consistent with the counterclockwise rotation of the mandible.

tipping and translation of first molars, is close to the pretreatment prediction.[14] Because the current patient had minimal crowding but severe protrusion, firm posterior anchorage (*OBS®s*) was indicated.

The ideal soft tissue display when smiling is 1-2mm of attached gingiva.[22] While orthodontists rate 2-3mm of gingival exposure as unattractive, general dentists and laypeople feel that >4mm is required to rate a smile as unattractive (*Fig. 3*).[23,24] A "*gummy smile*" may have both extra-oral and intra-oral dimensions.[25] The differential diagnosis for the current patient favored a dental origin because the morphology was not consistent with anterior dentoalveolar extrusion nor vertical maxillary excess. The patient's lips were incompetent at rest, but did contact with hypermentalis activity, so it was important to control the vertical dimension of occlusion (*Fig. 1*). The use of the maxillary anterior miniscrews was originally proposed by Lin et al.[26]

Extraction cases with gummy smile are recognized as challenging malocclusions for clear aligner treatment.[1-3,9] Ideal ClinCheck® simulations are difficult to achieve. The "*bowing*" and/or "*bite block*" effect[27] may enhance the gummy smile tendency or deepen the bite with conventional aligners, so miniscrews play a vital role in expanding the scope for clear aligner treatment.[28] As shown in Fig. 14, an extra-alveolar (*E-A*) retracting force on the dentition anchored with IZC OBS®s produced a favorable clockwise moment to deepen the plane of occlusion, but the position of the center of rotation (C_{rot}) in 3D was unknown. The C_{rot} for posterior rotation of the lower arch with mandibular buccal shelf OBS® is actually an axis of rotation in 3D that has been calculated with finite element analysis (*FEA*) of cone beam commuted tomography (*CBCT*)

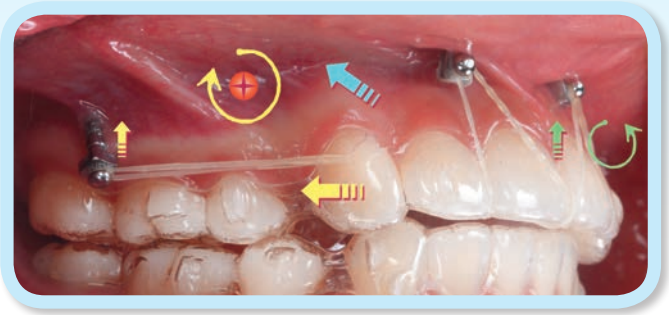

Fig. 14:
The force system is diagrammed in 2D to explain the mechanics in the sagittal plane for an IZC and Incisal OBS®s. Based on the presumed center of resistance (CR, red circle with a cross) for the maxillary arch, the elastic force from the IZC screws to the cuspid precision cut has both distal and vertical components (straight yellow arrows) that produce a clockwise moment around the CR (curved yellow arrow). The anterior I-R screws anchor an intrusive force (green arrow) that creates a counterclockwise moment (curved green arrow) tending to flare the maxillary incisors. The presumed resultant for overall applied loads is the blue arrow.

images.[29] The calculated C_{rot} was far more anterior and occlusal than previous 2D estimates. If the calculated C_{rot} is similar for IZC anchorage in the upper arch, E-A posterior anchorage has less of an effect on steepening the maxillary plane of occlusion to produce incisor extrusion than is implied in 2D (*Fig. 14*). The scientific evolution of IZC OBS® anchorage for aligner therapy requires 3D assessment of the C_{rot} because a relatively simple change in the direction of the elastics force may eliminate the need for Incisal OBS®s. Steepening the plane of the buccal elastic by screwing the OBS® deeper into the buccal fold and attaching the elastic near the cusp tip of the canine may eliminate the need for the uncomfortable and unattractive Incisal miniscrews. Patients desiring aligner treatment prefer the most esthetic and the least invasive approach, so eliminating Incisal miniscrews would be a very attractive option.

Realistic assessment of the 3D biomechanics relative to IZC anchorage for aligner treatment is not possible without FEA of CBCT images.[29] However, in the meantime 2D analysis is helpful for routine clinical applications (*Fig. 14*). When the buccal elastic force is parallel to the occlusal plane, clockwise rotation of the occlusal plane is expected to extrude the incisors. I-R OBS®s in the incisal anchorage position between the central and lateral incisor roots are essential for reversing the extrusive component on the anterior segment. In addition, the anterior vertical force resulted in a slight flattening of the occlusal plane and net intrusion of the maxillary arch (*Fig. 15*). The combination of all four OBS® fixtures (*2 IZC and 2 Incisal*) retracted and intruded

Fig. 15:
The application of anterior I-R screws to anchor elastics fitted into palatal cuts (blue curved lines) in the aligners is shown in the occlusal view (upper) and the frontal view (lower). The palatal cuts inclined to the mesial are good attachments for elastics attached the Incisal OBS®s bilaterally.

the maxillary incisors (*Fig. 13*). In addition, the roots in the buccal segments were well aligned (*parallel*) at the end of treatment, but they were perpendicular to the occlusal plane rather than distally oriented (*Fig. 2*). One can view the impressive results (*Figs. 11-13*) as achieving the full potential of aligners, but, more properly speaking, it was OBS® anchorage that expanded the scope of aligner treatment.[30] However, there is room for improvement particularly in regard to root angulations in the maxillary posterior segments.

Fig. 15 demonstrates the application of anterior I-R bone screws with elastics attached to "*inwardly inclined*" cuts on the palatal surface of the central incisors. The cuts are made chairside for every aligner specified with a special cutting plier. The patient fits elastics into the slots before seating the aligner on the arch, and then stretches the elastics over the Incisal bone screws with finger pressure (*Fig. 15*).

The overall failure rates for anterior I-R screws and IZC E-A screws are 7.2%[31] and 6.3%[32], respectively. The failure rates for TADs anchoring aligners is unknown, but the hypothesis is the failure rate will be lower for Incisal OBS®s because the applied force is lower and it is not applied full time. Further study is required to resolve this important issue.

All treatment objectives were met. Despite the patient's compliance in wearing aligners and elastics, there were Class II "*windows*" along the distal incline of the incisal edge of both maxillary canines, which extended posteriorly for all the interproximal intercuspation in the buccal segment (*Fig. 11*). This problem could be more clearly assessed with articulated casts. There were several contributing factors for the occlusal irregularities: (*1*) slight Class II relationship of the U3s and U4s, (*2*) inadequate distal moment of the U3 roots, and (*3*) insufficient extrusion of the L4s. In retrospect, closer monitoring of the ClinCheck® setup to resolve the Class II buccal segments may have indicated less IPR in the maxillary anterior region (*Fig. 10*) and more IPR of the lower anterior segment to create additional overjet to accommodate the Class II correction. In addition, distal root movement for all teeth in the maxillary buccal segments was needed. The roots were parallel (*Fig. 12*), but they were too upright to achieve an ideal intercuspation relationship. Overall, the result was excellent (*CRE 10*), but there was potential for a more ideal outcome.

The compensatory mechanism in the setups for Invisalign® extraction cases with miniscrew anchorage are similar to treating gummy smile cases. Four screws can prevent unattractive bowing effects, and at the same time save dozens of additional aligners. Once realistic 3D biomechanics are calculated,[29] it will be possible to further refine aligner alignment with TAD anchorage to achieve even more ideal results. The goal is to be competitive with the high accuracy for non-extraction aligner treatment.[33]

Conclusions

Closure of extraction spaces with Invisalign® appliances alone can be challenging and frustrating. Clinicians should be prepared for anterior dumping

and posterior torque loss. Prevention is better than cure. Aligners can be well integrated with TAD anchorage to execute a broad range of malocclusion corrections. Despite the excellent outcome for the current case, the treatment details should be carefully interpreted. 3D studies of the biomechanics are needed to formulate robust clinical recommendations.

Declaration of Patient Consent

The authors certify that they have obtained all appropriate patient consent documents. In the form, the patient has given her consent for her images and other clinical information to be reported in the journal. The patient understands that her name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of Interests

There are no conflicts of interest.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 21

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 = 0

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 = 1

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 = 1

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° = 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° 16 x 1 pt. = 16

Total = 17

OTHER (See Instructions)

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

Identify: Gummy smile correction.

Total = 2

Cast-Radiograph Evaluation

Patient

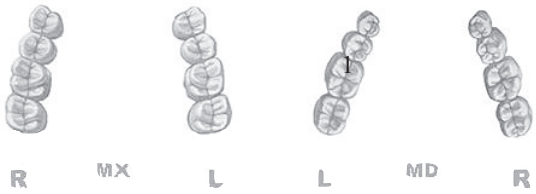
Total Score: 10

Alignment/Rotations

1

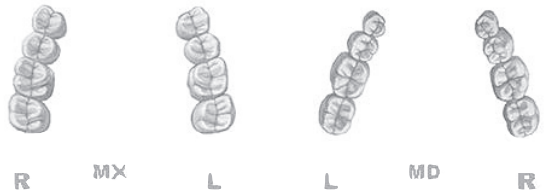
Marginal Ridges

0



Buccolingual Inclination

0

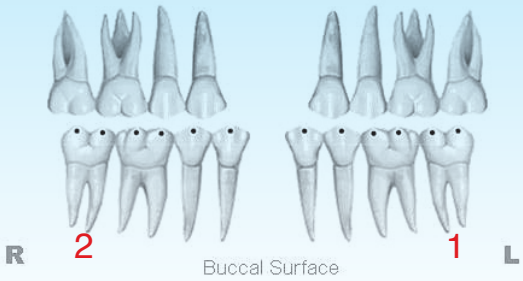


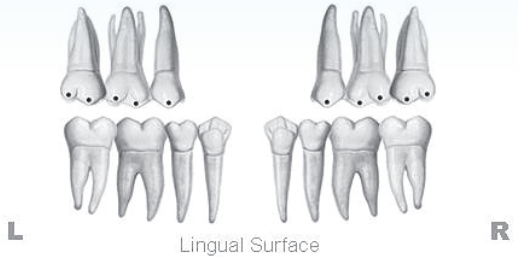
Overjet

0

Occlusal Contacts

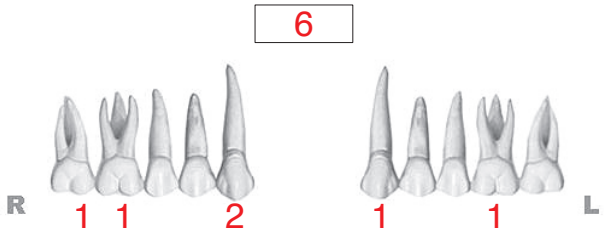
3





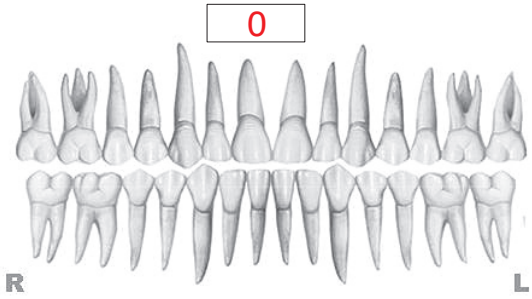
Occlusal Relationships

6



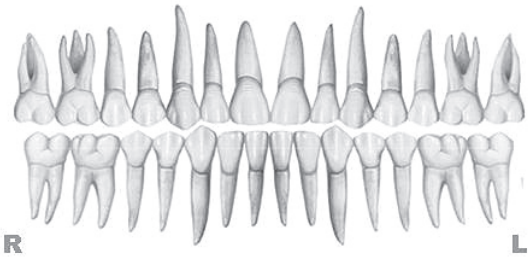
Interproximal Contacts

0



Root Angulation

0



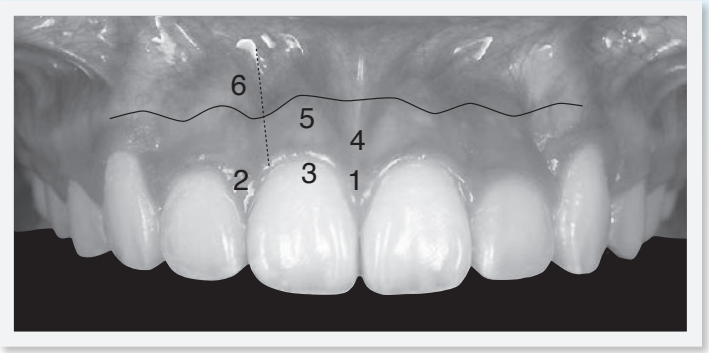
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 3

1. Pink Esthetic Score

Total = 2

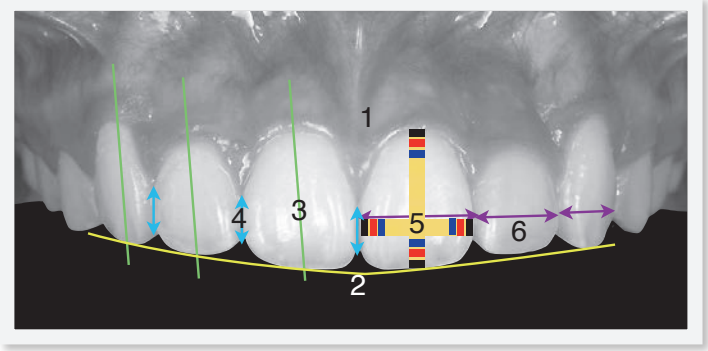


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

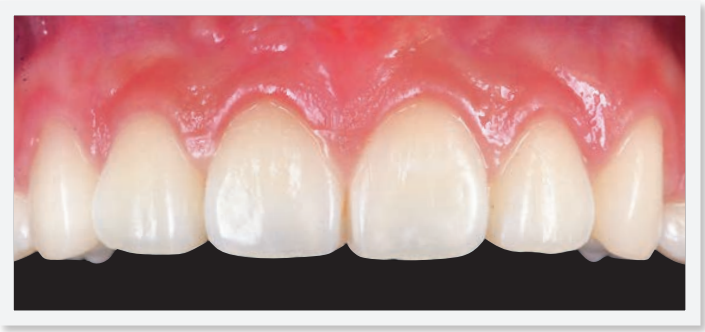
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	0	(1)	2
4. Level of Gingival Margin	0	(1)	2
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 1



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

2020~2021 第十二年度

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：

2021

7/21、8/11、9/8、10/20、11/17、12/15
1/12、2/23、3/16、4/13、5/11

- 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

全新的第十二年度 2020-21 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。

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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。

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預　賽：2020 年 12 月 30-31 日
決　賽：2021 年 1 月 1 日

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資格

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報名

12/5 日前向新竹市高爾夫球委員會報名。
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Extruding Crowded and Rotated Maxillary Lateral Incisors with Clear Aligners

Abstract

***History**: A 22-yr-7-mo-old female presented with chief complaints of poor dental esthetics and infra-occlusion, defined as intruded position relative to the occlusal plane.*

***Diagnosis**: Normal skeletal and dental relationships were associated with mild anterior crowding in both arches. Upper lateral incisors (UR2 and UL2) were in infra-occlusion, tipped labially, and rotated mesial-out. The Discrepancy Index (DI) was 22.*

***Treatment**: The ClinCheck® software was used to design Invisalign® clear aligners (Align Technology, Inc., San Jose, CA, USA) for correction of the moderate anterior alignment problems. Attachments were bonded on all teeth as indicated. Interproximal reduction (IPR) was specified as needed. During active treatment, the maxillary arch was expanded, but the aligners went off-track on the UL2. Additional aligners were designed with improved retention to extrude the UL2 and align the entire dentition as needed.*

***Results**: Alignment of the dentition was near ideal. The Cast-Radiograph Evaluation (CRE) score was 3, and the Pink and White dental esthetic score was 0.*

***Discussion**: Extruding lateral incisors in the presence of crowding requires extensive IPR. Adequate space for incisor alignment is required to avoid off-tracking due to distortion and poor retention of the aligners. Auxiliaries and horizontal rectangular attachments help ensure better aligner retention and interproximal confirmation.*

***Conclusions**: Clear aligners, with specified attachments and IPR, can efficiently align labially tipped, rotated, and intruded maxillary lateral incisors. (J Digital Orthod 2020;60:84-99)*

Key words:
Invisalign®, clear aligner treatment, extrusion, lateral incisor, interproximal reduction

Introduction

Anterior open bite is described as a very challenging malocclusion because of the high tendency to relapse.[1] Clear aligners are effective mechanics for anterior open bite correction because there is a double layer of aligner material on the occlusal surfaces.[2] On the other hand, it is difficult to axially extrude incisors to close the bite, particularly if the dentition is crowded.[3] Kravitz et al.[4] reported the average success for achieving a desired extrusion of maxillary central and lateral incisors was only 18.3% and 28.4%, respectively. Optimal mechanics with aligners requires excellent retention on malaligned teeth. Composite resin attachments are bonded on enamel surfaces as specified by the virtual treatment planning program, ClinCheck® (*Align Technology, Inc., San Jose, CA, USA*). Proper treatment planning with digital simulations is effective for dento-alveolar correction of open bite with clear aligners.[5-7]

Teeth with attachments can be rotated with clear aligners, but dissipation of force towards the gingival margin of the aligner may produce an intrusive "*side*

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

effect."[8,9] This undesirable sequelae is accentuated by a loss of tracking.[10,11] To facilitate complex tooth movement, optimized attachments are proposed by Invisalign® (*Align technology, Inc., San Jose, CA, USA*) to provide active force along the desired path of tooth movement.[12]

This article reports a clear aligner method for aligning flared, rotated, and intruded (*infra-version*) upper lateral incisors in a crowded arch. The selective interproximal reduction (*IPR*) of enamel, as well as the required mechanics with optimized attachments, is specified with ClinCheck®.

The dental nomenclature for this report is a modified Palmer notation. Upper (*U*) and lower (*L*) arches, as well as right (*R*) and left (*L*) sides, define four oral quadrants: UR, UL, LR, and LL. Teeth are numbered 1-8 from the midline in each quadrant, e.g., a lower right first molar is LR6.

Fig. 1: Pre-treatment facial and intraoral photographs

History and Etiology

A 22-yr-7-mo-old female presented with a chief complaint of poor dental esthetics. Pretreatment intraoral photographs, dental models, and radiographs are shown in Figs. 1-4. Clinical examination revealed a straight lateral profile, and the central incisors were in edge-to-edge occlusion. There was anterior open bite of 3 and 5mm for the right and left upper lateral incisors (*UR2, UL2*) respectively. From the occlusal view, UR2 showed a 30˚ mesial-out rotation, causing a 3mm overjet and openbite. A 45˚ mesial-out rotation and 4mm overjet with openbite was noted for the UL2. The long axis of UL2 also showed a 30˚ mesial tip from the profile perspective (*Fig. 5*). There was no midline deviation, but intra-oral examination revealed 6mm of crowding, primarily related to the mesially-rotated upper lateral incisors.

No contributing medical or dental history was reported. The etiology of the malocclusion was deemed to be inadequate arch development in width. Eruption of the upper canines blocked-out, rotated, and flared the adjacent lateral incisors. Cephalometric measurements before and after treatment are presented in Table 1.

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

Fig. 3: Pre-treatment panoramic radiograph

Fig. 4:
Pre-treatment cephalometric radiograph with the E-Line shown in blue

Diagnosis

Facial:

- Facial Height: *Na-ANS-Gn was increased (58%).*
- Lip Protrusion: *Normal lip profile (-1mm upper and 0mm lower) to the E-line*
- Symmetry: *No midline deviation (Fig. 1)*
- Smile Line: *Except for the infra-version lateral incisors, the upper anterior dentition corresponded to the curvature of the lower lip.*

Fig. 5:
Left: *UL2 (yellow arrow) was flared as shown in the profile view.* ***Center:*** *The frontal view shows infra-occlusion of UL2 and UR2. Extrusion is required (yellow arrows) to align teeth along the smile arch (white curved line).* ***Right:*** *As indicated in the occlusal view, 3 and 4mm of overjet were present for the UR2 and UL2 respectively.*

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	86°	88°	2°
SNB° (80°)	82°	84°	2°
ANB° (2°)	4°	4°	0°
SN-MP° (32°)	41°	39°	2°
FMA° (25°)	36°	34°	2°
DENTAL ANALYSIS			
U1 To NA mm (4mm)	1	4	3
U1 To SN° (104°)	98°	99°	1°
L1 To NB mm (4mm)	7	5	2
L1 To MP° (90°)	93°	86°	7°
FACIAL ANALYSIS			
E-LINE UL (-1mm)	0	1	1
E-LINE LL (0mm)	0	0	0
%FH: Na-ANS-Gn (53%)	58%	58%	0
Convexity: G-Sn-Pg' (13°)	8°	10°	2°

Table 1: Cephalometric summary

Skeletal:

- Intermaxillary Relationship: *Protrusive maxilla (SNA 86°) and mandible (SNB 82°)*
- Mandibular Plane: *Decreased (SN-MP 31°, FMA 23°) (Fig. 4)*
- Vertical Dimension of Occlusion (*VDO*): *Excessive Na-ANS-Gn (58%)*
- Symmetry: *Within normal limits (WNL)*

Dental:

- Classification: *Class I bilaterally*
- Overbite: *Edge-to-edge central incisors; 3mm open bite at UR2; 5mm open bite at UL2*
- Overjet: *4mm for UL2*
- Missing/Unerupted Teeth: *None*
- Symmetry: *No midline deviation*
- Crowding: *6mm in the upper arch*

The ABO Discrepancy Index (*DI*) was 22 as documented in the subsequent Worksheet 1.

Treatment Objectives

Maxilla (all three planes):

- A-P: *Maintain*
- Vertical: *Extrude anterior segment*
- Transverse: *Expand*

Mandible (all three planes):

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

Maxillary Dentition:

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

Mandibular Dentition:

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

Facial Esthetics:

- Maintain

Treatment Alternatives

The chief complaint was malaligned maxillary lateral incisors. Buccal segments were near Class I bilaterally. The extraction decision chart proposed by Chang and Roberts[13] suggested a non-extraction approach. Three treatment options were proposed:

Option 1: Fixed appliances to relieve crowding and extrude the upper incisors

Option 2: Clear aligner therapy with IPR, and bilateral infrazygomatic temporary anchorage devices (*TADs*)

Option 3: Clear aligner therapy with IPR only

Rationale: Fixed appliances are efficient for treating anterior rotations with open bite (*Option 1*), and TADs are effective anchorage (*Option 2*). However, the patient preferred Option 3, which was a conservative aligner treatment with IPR. She preferred a minimally invasive approach that was more esthetic during treatment.

Treatment Progress

ClinCheck® was applied in order to digitally plan and monitor the progress of treatment. An optimized attachment beveled on the disto-gingival surface was placed on UL2 for extrusion and rotation. A horizontal rectangular attachment beveled towards

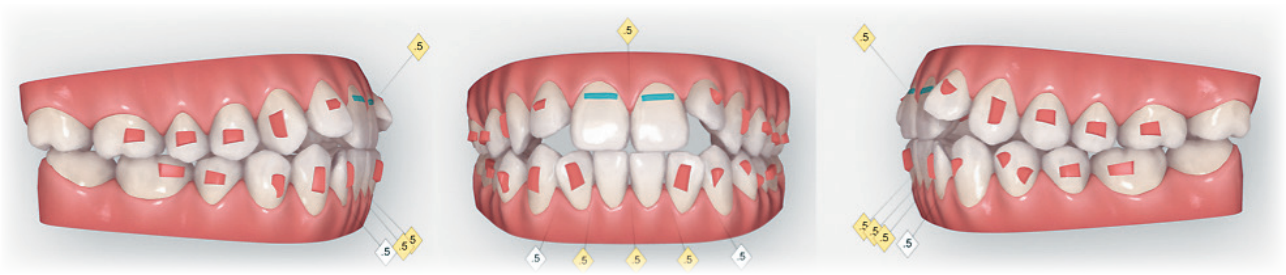

Fig. 6:
The initial setup with the prescribed attachments shows where the interproximal areas requiring IPR are. The amount of IPR required for each interproximal contact area is shown in the diamonds.

the gingiva was used for the extrusion of UR2. Conventional and optimized attachments were placed on other teeth as indicated to achieve a desired alignment (*Fig. 6*). Both arches were expanded slightly, and IPR was performed between lower and upper central incisors to relieve crowding. The Curve of Spee was flattened, and the interval for changing aligners was 10 days.

Two months into treatment, off-tracking was seen on UL2, with its attachment completely outside the corresponding aligner concavity when the 9th aligner was delivered (*Fig. 7*). The UL2 attachment was removed to prevent further distortion of the aligner and disrupted movement of other teeth. IPR on the mesial side of UL2 was also performed to facilitate rotation. The patient was instructed to continue wearing the current sequence of aligners until a revised set was delivered to correct UL2 alignment.

After 8 months of treatment, another set of intra-oral scans was performed, and additional aligners were designed using ClinCheck® (*Fig. 8*). The dentition was well aligned, except for rotations and tipping of upper and lower incisors. Both UL2 and UR2 were still gingival to the occlusal plane (*infra-occlusion*). Optimized attachments were designed for extrusion and mesial-in rotation of the upper lateral incisors. In addition, vertical rectangular attachments were placed on the lower lateral incisors to achieve mesial-out rotation.

Fig. 7:
At two months (2M) into treatment, off-tracking has occurred for the UL2.

Fig. 8:
Intra-oral scans of the upper arch at the 8th, 20th, and 25th month are shown with the prescribed attachments. Note the progress of extrusion and rotation for the UL2.

Off-tracking (*failed aligner retention*) was a continuing problem for the UL2. Additional aligners targeting the rotation and extrusion of the UL2 were designed and produced at the 20th and 25th month respectively (*Fig. 8*). After 30 months of treatment, the entire dentition was well aligned and articulated. All attachments were removed.

Results Achieved

Infra-occlusion of mesially-rotated upper lateral incisors (*DI=22*) was corrected to a near ideal occlusion (*CRE=3*) with 30 months of clear aligner treatment. IPR was performed as specified in the ClinCheck® treatment plan. The cephalometric analysis (*Table 1*) revealed that maxillary incisors were tipped anteriorly 1˚, and the mandibular incisors were tipped lingually 7˚. Overall, the patient was pleased with the facial and dental esthetics (*Figs. 9-11*). As shown in Figs. 12 and 13, as well as tabulated in Table 1, the specific achievements were:

Maxilla (all three planes):

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

Mandible (all three planes):

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

Fig. 9: Post-treatment facial and intraoral photographs

Fig. 10: Post-treatment dental model (casts)

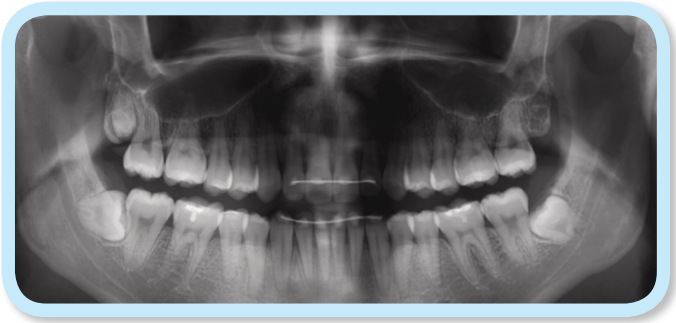

Fig. 11: Post-treatment panoramic radiograph

Fig. 12: Post-treatment cephalometric radiograph

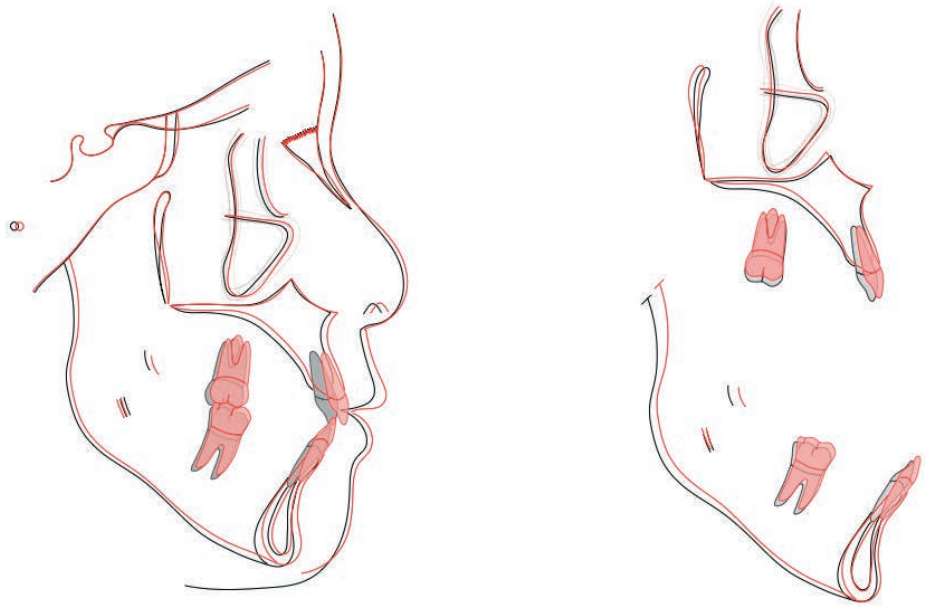

Fig. 13:
Cephalometric tracings before (black) and after (red) treatment document the dentofacial changes associated with aligner treatment. The superimpositions are on the cranial base (left), maxilla (upper right), and mandible (lower right). The upper and lower incisors were slightly protracted (tipped labially) to correct incisal crowding.

Maxillary Dentition

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

Mandibular Dentition

- A-P: *Slightly protracted incisors*
- Vertical: *Slight extrusion of lower incisors*
- Inter-molar/Inter-canine Width: *Maintained*

Facial Esthetics:

- Maintained

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® overlay retainers (*Dentsply Sirona, Charlotte, NC, USA*) 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 thereafter.

Final Evaluation of Treatment

A Class I occlusion with ideal overbite and overjet was achieved. The ABO Cast-Radiograph Evaluation (*CRE*) was 3 points (*Worksheet 2*). The only deficiencies were root axial inclination problems of the lower premolars, and excessive overjet of the UL2. The Pink and White esthetic score was 0 (*Worksheet 3*).

Discussion

This case report documents the near ideal correction of a difficult malocclusion. Infra-occlusion, rotation, and flaring of upper lateral incisors in a crowded dentition is a complex problem. Coordinated mechanics delivered concurrent extrusion, rotation, lingual tipping, and arch expansion to relieve crowding. Clear aligner therapy was applied for 30 months to align the maxillary lateral incisors. The expected treatment time was exceeded by at least 6mo. The treatment planning and difficulty experienced in delivering the required biomechanics needs further discussion.

Extrusion

Clear aligners move a tooth via deformation of the overlay material, which results in recoil against the contact surfaces of teeth. Undercuts and attachments provide retention for an aligner as it applies loads to individual teeth. Because of the divergent contour for most teeth, the net axial force is usually toward the gingiva. Distortion of the more compliant gingival margin of an aligner may allow interproximal contacts to open. Brezniak[8] vividly described the lack of aligner rigidity associated with bodily movement (*translation*) of a central incisor. These mechanics require a force of ~150g (*cN*) plus a moment up to 1600g-mm. Even when attachments are optimally designed and positioned, aligner distortion is inevitable when a significant load is applied. Intrusion may occur as a side effect. Furthermore, the lack of adequate undercuts around malaligned upper lateral incisors decreases the retention of aligners. To counter this

undesirable effect, attachments are necessary to improve retention and produce an extrusive force on teeth in infra-version.

Kravitz[4] evaluated extrusion of maxillary lateral incisors with clear aligners, and found a mean occlusal movement of only 0.56mm when several mm was needed. For increased predictability in improving smile esthetics, he suggested tipping the incisors distally as they are extruded. As demonstrated early in the treatment of the current patient, the "*relative extrusion*" due to lingual crown tipping was enhanced by labial surface attachments (*Fig. 8*). However, the actual extrusive movement was inadequate so "*absolute extrusion*" was required. It was evident that lingual tipping of the UL2 was achieved with the first set of aligners despite the history of off-tracking. This was probably due to the lingual force delivered to the labial surface by aligner contact. Off-tracking resulted in the loss of extrusive (*axial*) force, but lingual tipping remained efficient.

Improving aligner retention for labial surface attachments was crucial for efficient extrusion. Horizontal rectangular attachments beveled towards the gingiva are thought to retain aligners better than ellipsoid devices.[14] Optimized attachments are shaped like a half circle. This design tends to provide less retention than most conventional attachments. Karras[15] reported that conventional attachments are more effective than the optimized attachments for extruding central incisors. The position of the attachment results in variable loads applied to a tooth or teeth. A recent finite element analysis compared three attachment designs for extruding an upper central incisor. A rectangular attachment on the palatal surface is nearer to the center of resistance in the sagittal plane, and it yielded more efficient axial extrusion compared to the same attachment on the buccal surface.[3] Positioning attachments on the palatal surfaces of the dentition in ClinCheck® may facilitate tooth movement, but could result in occlusal interference with the lower dentition. Conventional attachments may result in an overcorrection,[4] particularly when auxiliaries such as buttons and elastics are used to improve the fit of the aligner.[16] Efficient extrusive mechanics must be carefully monitored.

Rotation

Rotation of incisors is more predictable than for more rounded teeth such as canines and premolars.[17] However, a study evaluating rotation of a central incisor with clear aligners found a net intrusive force because the aligner primarily contacted the tooth near the incisor edge.[18] A finite element analysis of lower premolar rotation found that intrusion is an inevitable complication during rotation due to distortion at the aligner margin.[9] This intrusive force demonstrates what Breziniak[8] described as the "*watermelon seed*" effect. For the present patient, rotating the upper lateral incisors was hampered by the interference of the central incisor due to inadequate space. Loss of tracking (*failure of aligner retention*) occurs in rotation when there is inadequate space so that the lateral incisor engages the adjacent central incisor. The off-tracking essentially eliminates the extrusive force as previously discussed.

Flaring

Invisalign® is more effective for lingual tipping than for extrusion of incisors, so Kravitz[4] proposed performing a "*relative extrusion*" to close anterior open bite, as discussed above. These mechanics were applied to the present patient because the upper lateral incisors were flared prior to treatment (*Fig. 8*). However, poor vertical control and interference with the central incisor inhibited palatal tipping of the lateral. Furthermore, the desired camouflage effect[4] was not achieved because lingual tipping was inhibited. Adequate space for displaced teeth must be provided with IPR and/or expansion of the arch circumference. Another common source of intrusive force occurs when correcting labially inclined buccal segments.[19] As the axial inclination is corrected, retention of the aligner by the labial attachments may be compromised, leading to off-tracking. This potential problem must be carefully monitored by the patient and the doctor.

Managing a Crowded Dentition

Interference from the central incisors due to anterior crowding was an important factor leading to off-tracking for the present patient (*Figs. 5-7*). Alignment with Invisalign® usually requires labial tipping of the incisors and interproximal reduction (*IPR*).[20,21] However, IPR between UL1 and UL2 was not planned with ClinCheck® because the algorithm did not detect a collision. Thus, there was inadequate arch circumference for alignment of the upper lateral incisors, so the UL2 did not tip distally as planned, which led to off-tracking. It is important for the doctor to recognize the limitations of a ClinCheck® treatment plan and revise it if needed. Unusual 3D anatomy such as tipped, intruded, and rotated upper incisors is a challenging problem.

To facilitate tooth movement, IPR was performed periodically, but it was inadequate to align both upper lateral incisors. Routine IPR achieves only 35% of the intended increase in arch circumference because of movement of the tooth within the periodontal ligament.[22] In effect, the incisors flare slightly, presenting the illusion that adequate IPR has been achieved. Treatment was extended due to poor control in tipping of the UL2 distally, which was resulted from insufficient IPR and the overlapping of the crown with adjacent central incisor.

Unrealistic Optimized Attachments

An advantage of optimized attachments is the defined moment-to-force ratio for improving root movement,[23] but they must be properly positioned.[24] The vast data set collected by Align Technology provides good predictability for the indeterminate mechanics delivered by full arch aligners, but midcourse correction is almost always required for an ideal result. Reliance on optimized attachments to achieve an optimal outcome with one stage of treatment is unrealistic. Instead, correction of a malocclusion should be divided into stages. Additional scans and Clincheck® analysis after each stage provide specific treatment objectives to achieve an optimal outcome in a stepwise manner.

Proposed Plan

In retrospect, virtual planning on the ClinCheck® failed to account for the difficulty of the malocclusion, and for the limitations of aligners for correcting

tipped and rotated incisors. Maintaining retention of the aligner to avoid off-tracking should be the top priority. Generous IPR was required to avoid interference with adjacent teeth as the malocclusion was corrected. A vertical attachment on the labial surface was indicated to improve retention. If open bite persists, a horizontal attachment beveled to the gingiva is useful for absolute extrusion. Buttons and elastics are useful for ensuring a firm grip on the dentition. Frequent use of Chewies to help seat the aligners, as well as increasing the interval of aligner progression, may be helpful for achieving more efficient tooth movement.

Conclusions

Optimized attachments designed by ClinCheck® effectively extrude rotated maxillary lateral incisors in infra-occlusion due to a crowded dentition. However, off-tracking is a common complication. IPR and the staged use of attachments are efficient options for ensuring the retention of aligners to accelerate treatment.

Fig. 14 documents the current condition of the patient 2 years post-treatment.

Fig. 14: Facial and intraoral photographs at 2-year follow-up

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 22

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 = 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° = 4 pts.

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

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

SN-MP

≥ 38° = 2 pts.

Each degree > 38° 3 x 2 pts. = 6

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 8

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 =

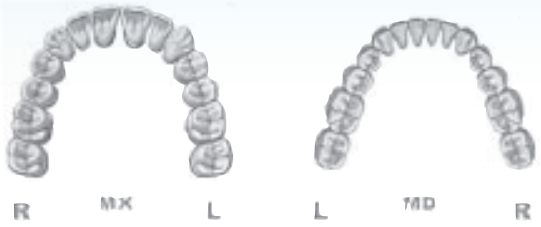
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 3

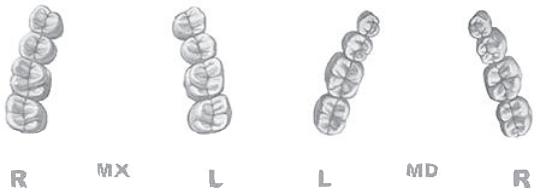
Alignment/Rotations

0



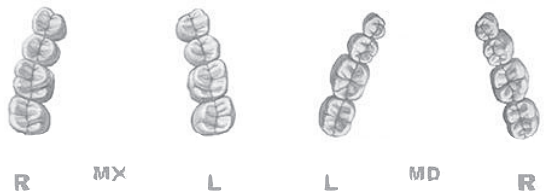
Marginal Ridges

0



Buccolingual Inclination

0

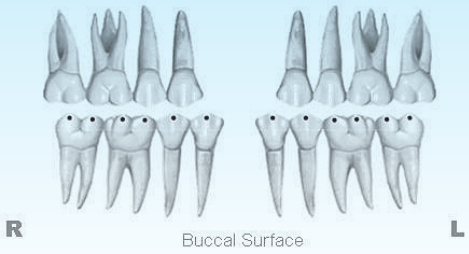


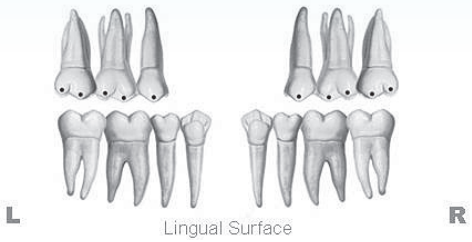
Overjet

1

Occlusal Contacts

0



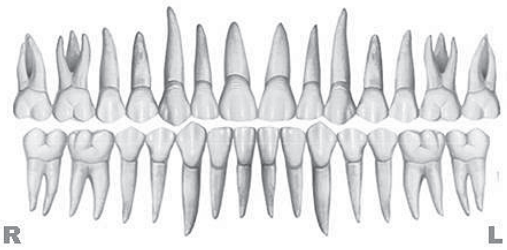


Occlusal Relationships

0

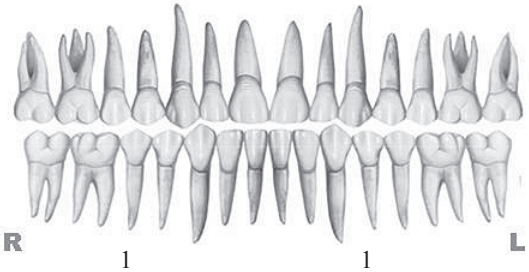
Interproximal Contacts

0



Root Angulation

2



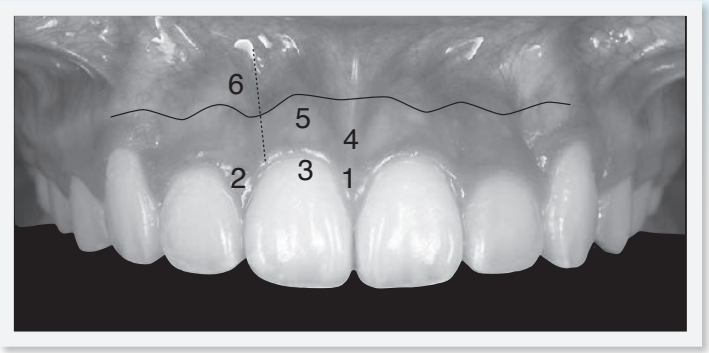
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 0

1. Pink Esthetic Score

Total = 0

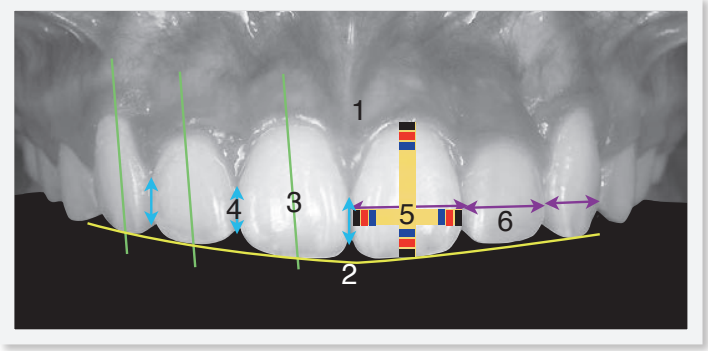


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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 = 0



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

2020 Implant Forum

本課表僅供參考，植牙論壇保留課程變動之權利

均可單堂報名

	日期（週五）	專題演講 9:00 - 10:30		植牙案例報告 10:45 - 12:00（30 分鐘 / 人）
1	3/13	陳明時 醫師（台灣假牙牙醫學會長、美國俄亥俄州立大學牙醫學院助理教授、美國加州州立大學舊金山牙醫學院副教授、台北醫學大學假牙研究所臨床教授） 主題：如何在自然牙根或者人工牙根建立穩定又平衡的咬合		
2	4/24	陳禮凡 醫師（長庚紀念醫院牙周病科兼任臨床指導主治醫師、美國波士頓塔夫茲大學牙周病專科醫師及牙周病碩士、美國牙周病專科醫學會專科醫師、中華民國植牙醫學會秘書長及專科醫師、禮凡牙醫診所院長） 主題：Advanced surgical techniques in implant dentistry	蕭浩宜 醫師（美國南加州大學植牙研究所進修、新綠牙醫診所院長）	張慧男 醫師（美國印第安那普渡大學齒顎矯正研究所博士）
3	5/22	吳尚霖 醫師（臺大醫院補綴科兼任主治醫師、耕莘醫院湖口仁慈分院主治醫師、尚霖牙醫診所負責人） 黃冠傑 技師（富緻牙體技術所牙技師、臺北科技大學經營管理EMBA、中臺科技大學牙體技術科學士） 主題：DTX Studio™ 數位化軟體應用 & 手術導板設計與生產		
4	6/12	胡剛碩 主任（新光醫院一般牙科主任、臺灣牙周病醫學會學術副主委、中華民國家庭牙醫學會學術副主委、台北市牙醫師公會學術委員） 主題：如何治療及避免植體周圍炎		
5	7/24	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） 主題：垂直前庭切線骨膜下隧道法 **下午另有 Hands-on 課程**		
6	8/28	謝清堯 醫師（台大牙醫系學士、台大臨床牙醫研究所補綴碩士、台大補綴科總醫師、台大補綴科兼任主治醫師） 主題：數位牙科的整合與應用		
7	9/25	林森田 醫師（中山醫學大學學士、國際矯正植牙學會院士、美國南加州大學植牙研究所進修） 翁蔚任 醫師（中華民國植牙醫學會專科醫師、中華民國家庭牙醫學會專科醫師、高雄醫學大學牙醫學士） 主題：From A to Z：完成你的第一個全口重建案例		
8	10/16	柯秋賢 醫師（竹北柯牙醫院長、高雄醫學大學牙醫學士、牙醫學研究所碩士、亞洲齒列再生研究會會員、中華植體美學醫師學專科醫師） 主題：Case report using the X-Guide dynamic navigation: From single tooth replacement to full mouth rehabilitation	黃育新 醫師（國際矯正植牙學會院士、台北醫學大學牙醫學系學士、台灣植牙醫學會專科醫師）	張慧男 醫師（美國印第安那普渡大學齒顎矯正研究所博士）
9	11/27	邱上珍 醫師（美國明尼蘇達大學牙周病學碩士、美國牙周病學會院士） 題目：Osseodensification and Densah Bur 的臨床運用 **下午另有 Hands-on 課程，可參考隔頁（費用另計）**		
10	12/18	黃怡豪 醫師（美國密西根大學牙周病專科認證、美國天普大學口腔生物學碩士、台灣大學附設醫院牙周病科兼任主治醫師、台北市牙科植體學學會副理事長） 主題：即拔即種與前牙美學究極		

地點：新竹市建中一路25號2樓（金牛頓藝術科技）

時間：每月一次、星期五上午 9:00-12:00

報名專線：03-5735676 #203

clinton@newtonsa.com.tw 陳建名

2020/11/27 (五)

邱上珍 醫師

主題：Osseodensification and Densah Bur 的臨床運用

課程時間：09:00～16:00

2014 年 Dr. Huwais 發明 Densah® Bur，應用 Osseodensification 自體骨緻密術的觀念，經由特殊設計的 Bur，在鑽骨的同時，利用反向切削與水壓動力，保留骨屑，並將骨屑往兩側的骨小樑間隙推擠，使植體周圍的骨質更加緻密；同時也利用骨頭本身的彈性體特性，使切削下的骨屑在骨頭回彈時，填入植體螺紋間隙，增加植體和骨頭的接觸面積比例，幫助癒合。此外，Densah® Bur 也可運用在齒脊擴張與上顎竇增高術，是您臨床有利的幫手。

2019 年 10 月，Dr. Huwais 本人來台灣授課，講師邱上珍醫師參與其中。這次課程邱醫師將清楚闡釋 Dr. Huwais 上課的重點，並分享她個人的使用經驗。下午的 Hand-on 課程，將讓您實際體驗 Densah® Bur 的魅力，並了解操作的細節。有興趣的醫師千萬不要錯過！

課程人數僅限 20 人，報名請趁早喔！

報名資訊

聯絡人: 3a Amy

連絡電話: 03-2209722#20 (8:30-17:30)

官方LINE ID: @3aonline

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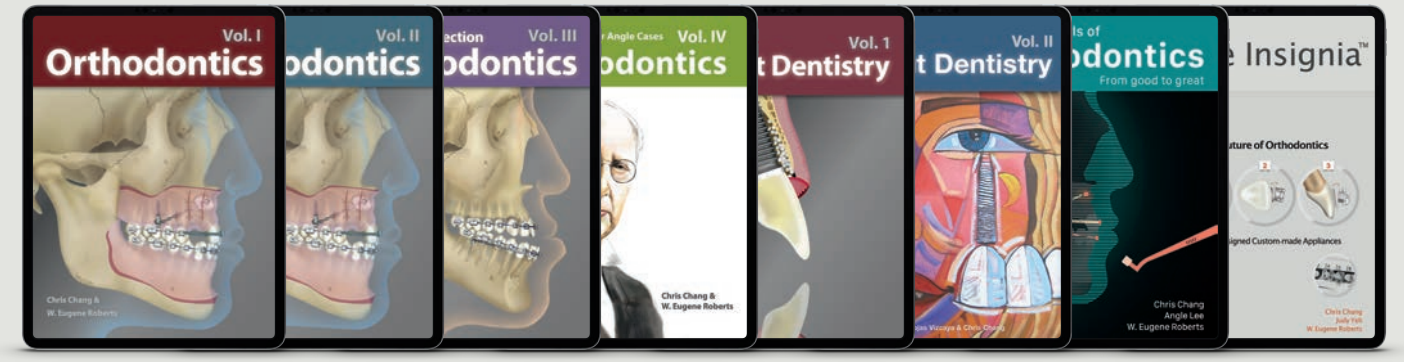

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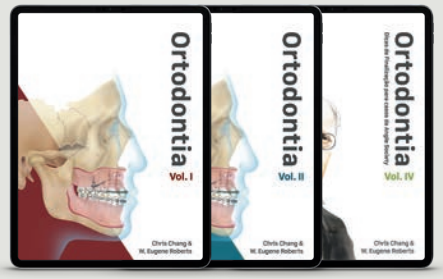

2021 一年一度 預報享優惠價 Damon Master Program


+


全新改版的 2021 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，本年度亦特別加入最新的**數位矯正與隱形牙套**的內容，並邀請了貝多芬牙科集團各院院長演講**特別矯正專題**。

此外，透過數位影片反覆觀看，結合矯正與電腦教學，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。

名額有限，一年僅有一次機會在台完整體驗 Damon 矯正大師課程，錯過只能等明年囉！

Module 1 - 4/22

1. Selecting your ideal first case
2. Bonding position
3. Bonding + BT + Ceph tracing
4. TADs + space closing + hook + spring
5. Finishing bending & fixed retainer

Practice: Clinical photography

Module 2 - 5/13

1. Four stages of efficient orthodontic treatment
2. Simple and effective anchorage system
3. Extraction vs. Non-extraction analysis

Practice: Patient photo management

Module 3 - 5/27

1. Soft & hard tissue diagnostic analysis
2. Big overjet correction
3. Damon diagnosis & fine-tuning

Practice: Ceph tracing

Module 4 - 6/17

1. Excellent finishing
2. Retention & relapse

Practice: Ceph superimposition & measurement

Module 5 - 7/8

1. Simplify your system
2. Extraction vs. non-extraction

Practice: Case report demo

Chairside observation - (TBA)

Chairside observation & clinic management

▲ **Computer training (Mac): 1:30-2:30 pm**

Module 6 - 8/5

1. Class III correction
2. Class II correction

Topic: Early orthodontic treatment (曾淑萍醫師)

Module 7 - 9/9

1. Upper impaction
2. Lower impaction
3. Gummy smile correction

Topic: Modfied VISTA (蘇筌瑋醫師)

Module 8 - 9/16

1. ABO DI, CRE workshop
2. Open bite

Topic: Modified 2X4 appliance in ortho treatment (徐玉玲醫師)

Module 9 - 10/21

1. Asymmetry
2. Implant-ortho combined treatment
3. Interdisciplinary treatment-adult complex cases

Topic: Interdisciplinary approach (邱上珍醫師)

Module 10 - 11/11

1. Minor surgeries in orthodontics
2. Digital orthodontics

Topic: Ortho-viewed interdisciplinary treatment (徐重興醫師)

Module 11 - 12/23

1. Aligner & TADs
2. Keys to aligner learning

Topic: Pre-aligner treatment (林詩詠醫師)

▲ **Special lecture: 1:30-2:30 pm**

時間：週四全天（9 am - 5 pm）

地點：金牛頓藝術科技（新竹市建中一路 25 號 2 樓）

費用含課程視訊、iPad、課程電子書與材料。

報名專線 湧傑 Yong Chieh

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"From this book we can gain a detailed understanding of how to utilize this ABO system for case review and these challenging clinical cases from start to finish."

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"Chris Chang's genius and inspiration challenges all of us in the profession to strive for excellence, as we see him routinely achieve the impossible."

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"This method of learning is quantum leap forward. My students at Oklahoma University will benefit greatly from Chris Chang's genius. "

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Dr. Robert S Chen, California, USA

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Dr. John Freeman, California, USA

"Tremendous educational innovation by a great orthodontist, teacher and friend."

Dr. Keyes Townsend Jr, Colorado, USA

"I am awed by your brilliance in simplifying a complex problem."

Dr. Jerry Watanabe, California, USA

"Just brilliant, amazing! Thank you for the contribution."

Dr. Errol Yim, Hawaii, USA

"Beyond incredible! A more effective way of learning."

Dr. James Morrish Jr, Florida, USA

New Release!

In an online lecture in early September, Dr. Chris Chang shared his experiences treating patients using aligners in combination with TADs. The lecture attracted over 3,000 doctors, which was a record for such an orthodontic webinar.