Skeletal Class I Malocclusion with Severe Crowding and Anterior Crossbite Treated with 4 First Premolar Extractions

Abstract

History: *A 19yr-6mo-old female presented with chief complaints of severe crowding and an anterior crossbite.*

Diagnosis: *The skeletal Class I malocclusion (SNA, 83.5˚; SNB, 85˚; ANB, -1.5˚) was associated with severe crowding (> 7 mm) and an anterior crossbite. The Discrepancy Index was 12.*

Treatment: *Bilateral maxillary and mandibular first premolars were removed to gain space for relieving the crowding and retracting the anterior segment to correct the anterior crossbite. A Damon® system appliance with passive self-ligating brackets was applied to correct the dental malocclusion after extracting four premolars.*

Results: *Improved dentofacial esthetics and occlusal function were achieved after treatment. The Cast-Radiograph Evaluation score was 24, and the Pink and White esthetic score was 2.*

Conclusions: *This case report demonstrates the use of passive self-ligating appliances and open coil springs to resolve an anterior crossbite and severe crowding. Furthermore, the application of Class II elastics during the closure of extraction spaces corrected the proclination of the upper anterior teeth. (J Digital Orthod 2024;73:4-18)*

Key words:

Skeletal Class I, proclined anterior teeth, anterior crossbite, passive self-ligating brackets, Class II elastics, first premolar extraction

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). Teeth are numbered 1-8 from the midline in each quadrant.

Introduction and Etiology

Bimaxillary crowding with a Class I molar relationship is a prevalent issue throughout the Asian population.[1] Crowding not only affects appearance but can also contribute to periodontal problems due to challenges in maintaining oral hygiene. Extracting four first premolars is an efficient way to relieve bimaxillary crowding,[2] but other factors such as facial profile, lip protrusion, and mandibular plane angle must also be taken into consideration.

Managing torque control, which involves maintaining the desired axial inclinations of teeth, can be challenging when closing extraction spaces. This case report outlines the treatment of bimaxillary crowding using extractions, and details effective torque control measures for retracting the maxillary incisors.

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Diagnosis

A 19-year-old female presented for orthodontic consultation with chief complaints of anterior crossbite and crowding (Figs. 1 and 2). No contributing medical or dental histories were reported.

The plaster casts revealed severe crowding (> 7 mm) (Fig. 3). The radiographic documentation of the malocclusion includes a lateral cephalometric film in centric occlusion (C_O) (Fig. 4), a panoramic radiograph (Fig. 5), and temporomandibular joint (TMJ) views (Fig. 6). There were no signs nor symptoms of temporomandibular dysfunction. The

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

Fig. 2:
Pre-treatment photograph shows anterior crossbite and an edge-to-edge incisor relationship.

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

American Board of Orthodontics (ABO) Discrepancy Index (DI) was 12 as shown in the subsequent Worksheet 1.[3] Cephalometric analysis was summarized in Table 1.

Facial:

• Convexity: *concave (G-Sn-Pg, -3˚)*

• Lip protrusion: *Within normal limits (WNL) (upper/ lower lips were -2 mm/0 mm to the E-line.)*

Fig. 4: Pre-treatment cephalometric radiograph

Fig. 5: Pre-treatment panoramic radiograph

Fig. 6:
Pre-treatment transcranial radiographs of the temporo-mandibular joints (TMJs) are shown, from the left: right TMJ closed, right TMJ open, left TMJ open, and left TMJ closed. The mandibular condyles are outlined in blue.

Skeletal:

- Skeletal Class I (ANB, -1.5˚), normal maxilla (SNA, 83.5˚), and mandibular prognathism (SNB, 85˚)

- Mandibular plane angle: *Normal (SN-MP, 29˚; FMA, 22˚)*

Dental:

- Molar relationship: *Class I on both sides*

CEPHALOMETRIC SUMMARY			
	PRE-TX	POST-TX	DIFF.
SKELETAL ANALYSIS			
SNA˚ (82˚)	83.5˚	82.5˚	1˚
SNB˚ (80˚)	85˚	84˚	1˚
ANB˚ (2˚)	-1.5˚	-1.5˚	0˚
SN-MP˚ (32˚)	29˚	30˚	1˚
FMA˚ (27˚)	22˚	23˚	1˚
DENTAL ANALYSIS			
U1 TO NA mm (4mm)	6	5	1
U1 TO SN˚ (104˚)	115.5˚	110˚	5.5˚
L1 TO NB mm (4mm)	4	1	3
L1 TO MP˚ (90˚)	90.5˚	78	12.5˚
FACIAL ANALYSIS			
E-LINE UL (-1mm)	-2	-3	1
E-LINE LL (0 mm)	0	-2	2
%FH: Na-ANS-Gn (56%)	56.5%	55.5%	1%
Convexity: G-Sn-Pg (13˚)	-3˚	0˚	3˚

■ *Table 1: Cephalometric Summary*

- Upper incisor: *protrusive and proclined (U1-NA, 6 mm; U1-SN, 115.5˚)*

- Lower incisor: *WNL (L1-NB, 4 mm; L1-MP, 90.5˚)*

- Overjet/overbite: *0 mm/0 mm (edge-to-edge)*

- Severe crowding (> 7 mm)

- Anterior crossbite (UR2 and UL2)

Treatment Objectives

1. Correct the anterior crossbite and the edge-to-edge relationship of U1s.

2. Relieve the severe crowding.

3. Retract and retrocline U1s.

4. Achieve a desired profile.

Treatment Plan

According to Chang's Extraction Decision Table (Table 2), extraction is the first choice for a case with flared central incisors and severe crowding.[5] Since the patient was willing to have teeth extracted, UR4, UL4, LR4, and LL4 were scheduled for extraction prior to active treatment in order to create enough space to relieve the anterior crowding and retract the flared anterior teeth. Closing the extraction space by retracting the anterior segment would also lead to the retraction of the lips. To correct the anterior-posterior relationship between the maxillary and mandibular dentitions, the use of Class II elastics was

Table 2: *Chang's Extraction Decision Table*

indicated.[5] To correct the anterior crossbite, open coil springs were planned to be introduced for creating spaces between U1s and U3s.
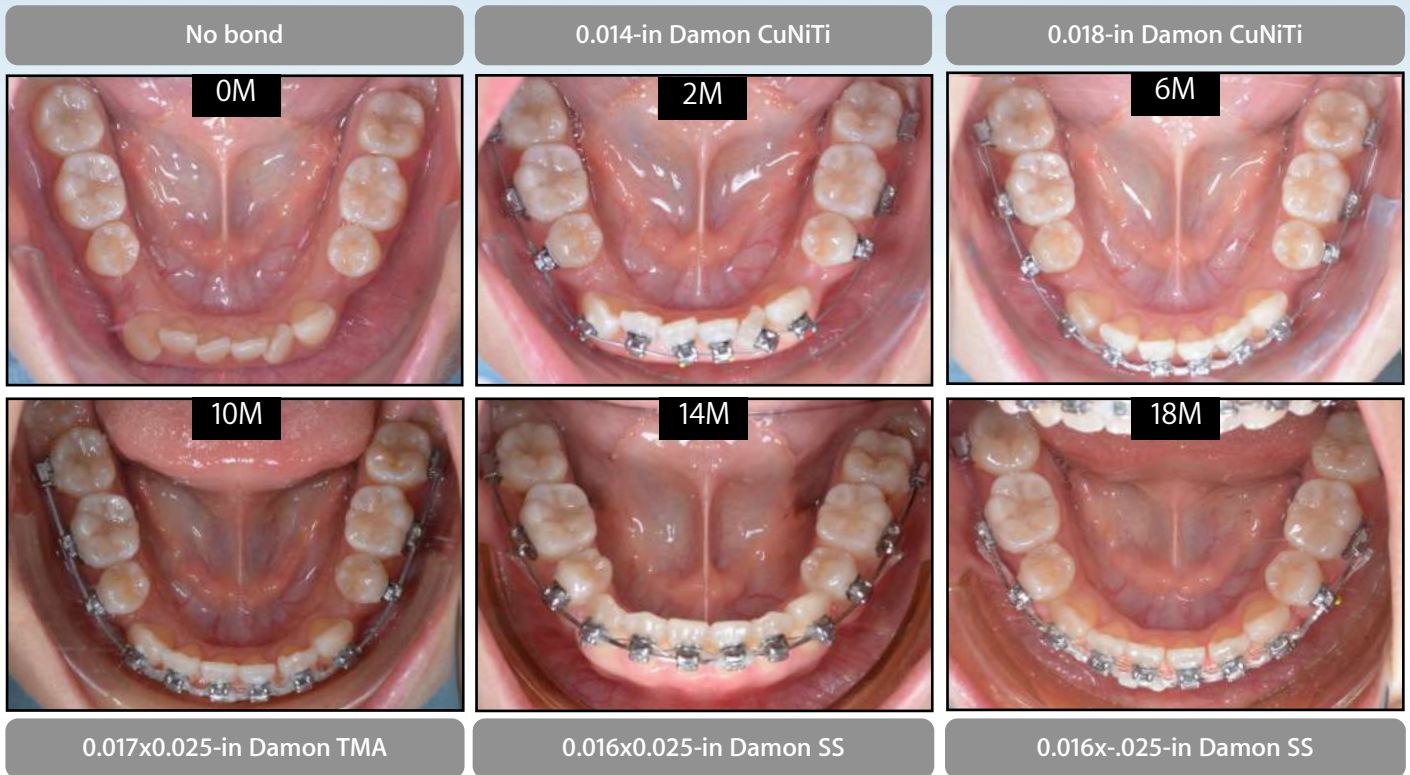
Treatment progress

The treatment progress is documented from the right buccal, frontal, left buccal, upper occlusal, and lower occlusal views, respectively (Figs. 7-11); the archwire sequence is shown in Figs. 7 and 8.

Before active orthodontic treatment, the patient was referred to have UR4, UL4, LR4, and LL4 extracted. A Damon Q® fixed appliance self-ligating (PSL) brackets featuring 0.022-inch slot and passive
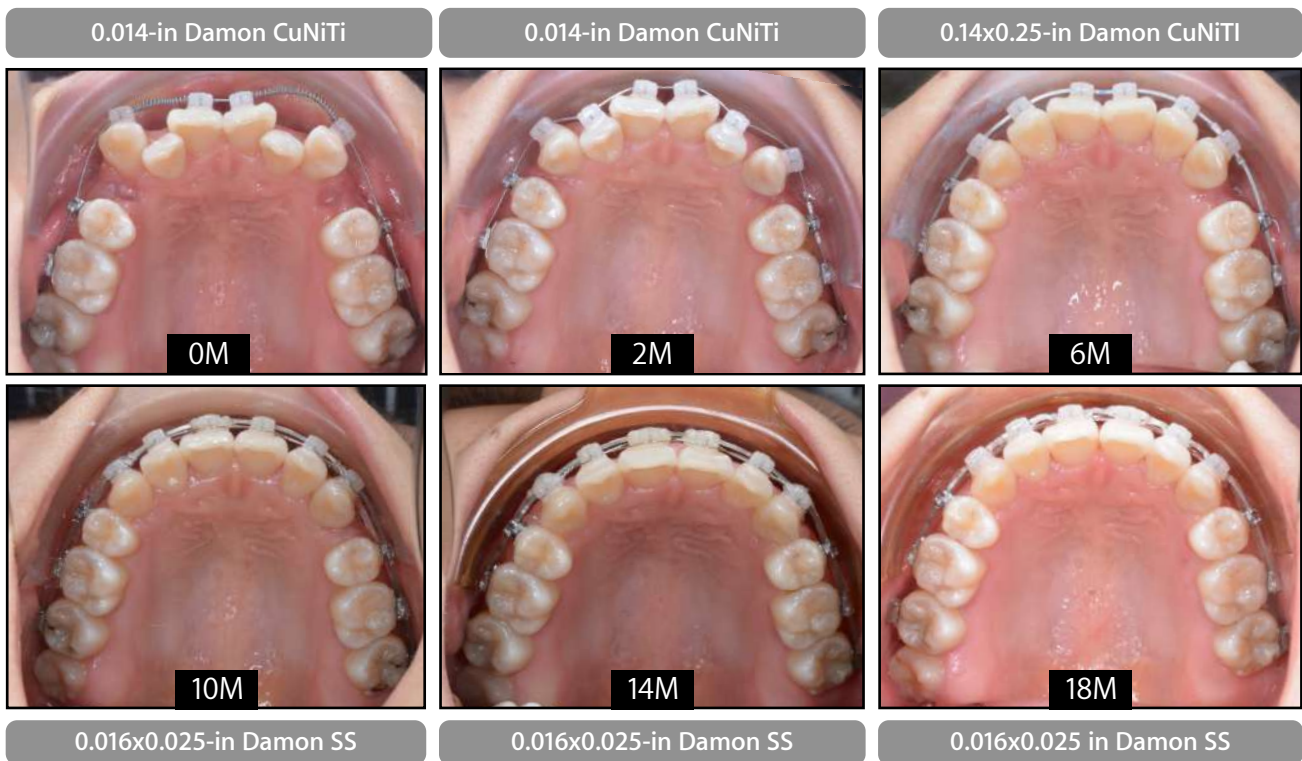

Fig. 7:
Treatment progress from the maxillary occlusal view is shown in months (M): 0M, 2M, 6M, 10M, 14M, 18M, with archwire specifications provided in grey boxes.

| No bond	0.014-in Damon CuNiTi	0.018-in Damon CuNiTi
0M	2M	6M
10M	14M	18M
0.017x0.025-in Damon TMA	0.016x0.025-in Damon SS	0.016x-.025-in Damon SS

■ *Fig. 8:*
Treatment progress from the mandibular occlusal view is shown in months (M): 0M, 2M, 6M, 10M, 14M, 18M, with archwire specifications provided in grey boxes.
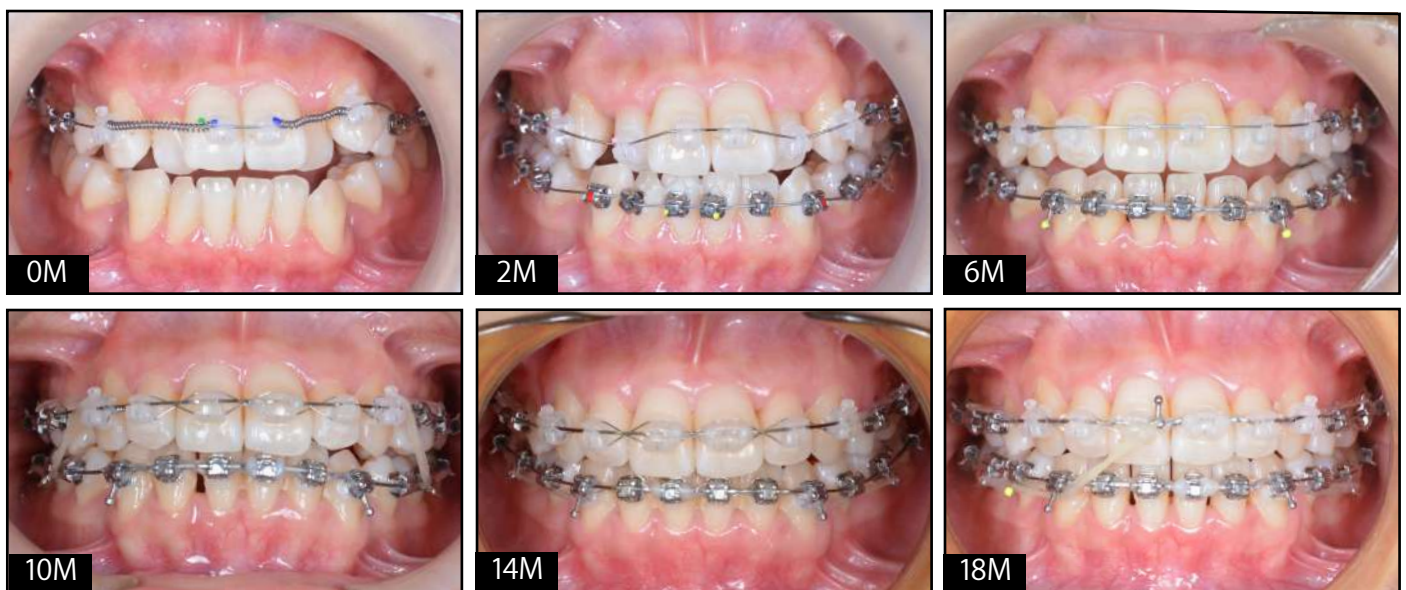
■ *Fig. 9: Frontal view of the treatment sequence is shown in months (M): 0M, 2M, 6M, 10M, 14M, 18M.*
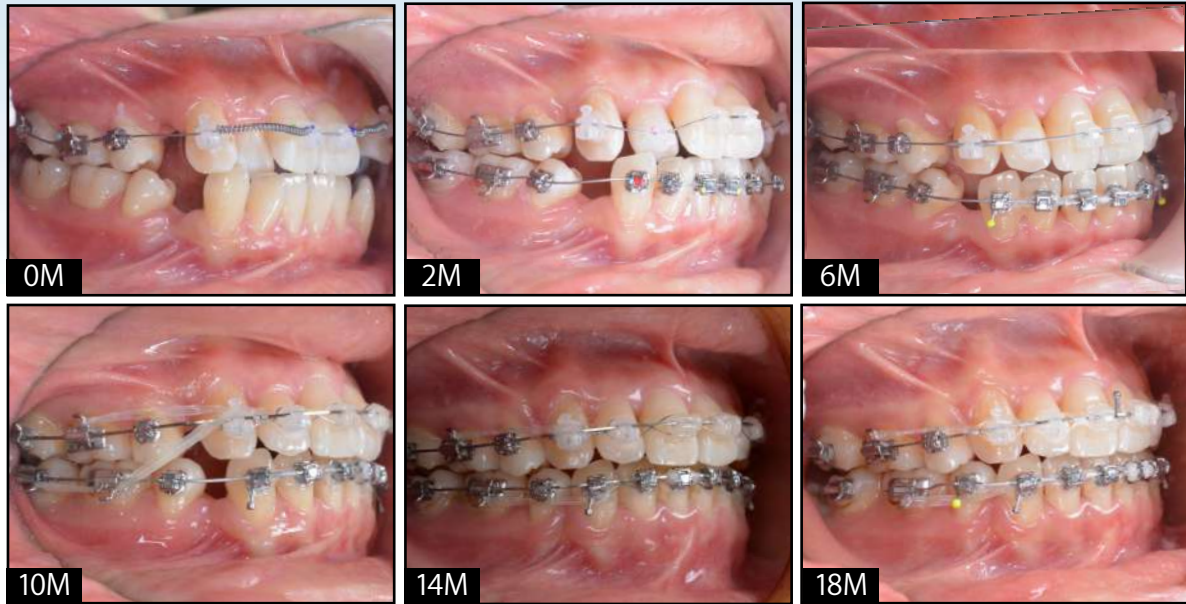
Fig. 10: *Right buccal view of the treatment sequence is shown in months (M): 0M, 2M, 6M, 10M, 14M, 18M.*
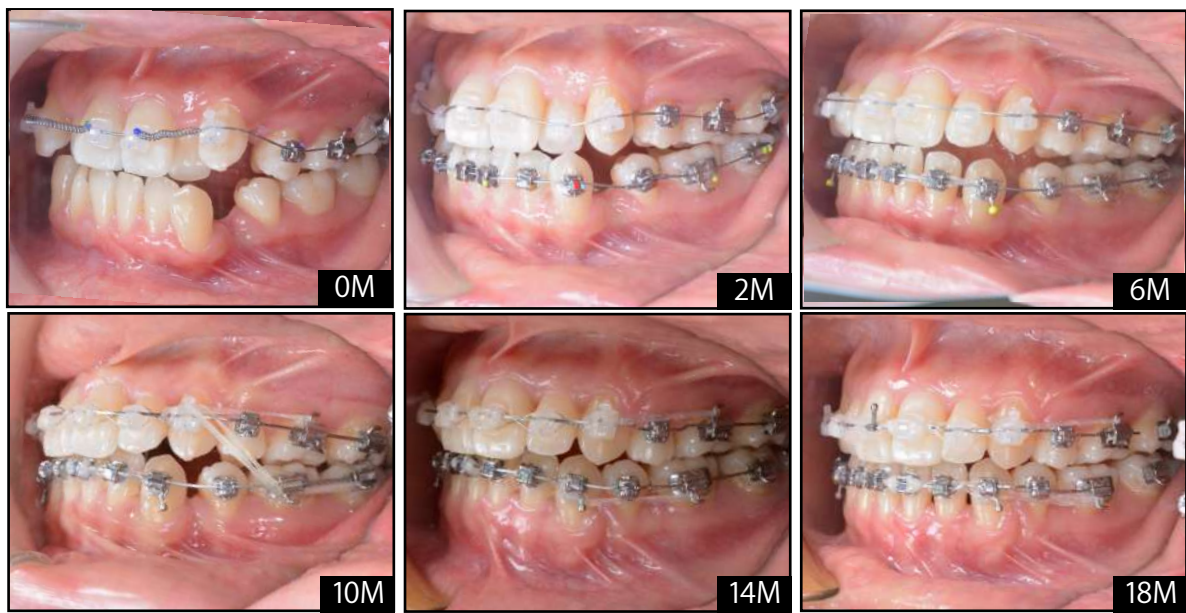
Fig. 11: *Left buccal view of the treatment sequence is shown in months (M): 0M, 2M, 6M, 10M, 14M, 18M*

self-ligating (PSL) brackets, and all designated archwires and orthodontic auxiliaries were included.

At the start of the treatment, the brackets were bonded on all upper teeth except for U2s. Standard-torque brackets were chosen for U1s and high-torque brackets were chosen for U3s. A 0.014-in CuNiTi archwire was engaged on the upper arch. Two open coil springs were placed between U1s and U3s on both sides to create space.

■ **Fig. 12:**
Space consolidation with power tube from UR2 to UL2 in 17th moth

Following a month of space opening, sufficient space for the U2s was successfully attained, so the open coil springs were subsequently taken out. The lower dentition was also bonded with PSL brackets. Standard-torque brackets were placed on the lower incisors, while high-torque brackets were placed on the lower canines.
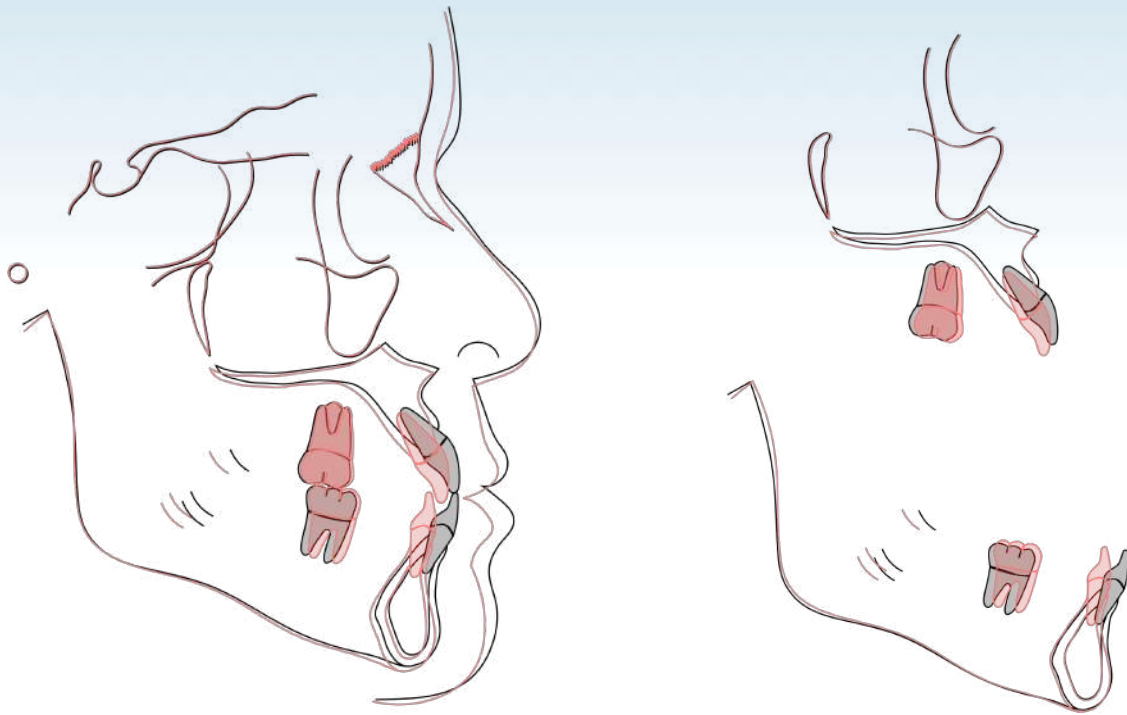
By the 6th month, the anterior crossbite on both sides were successfully corrected, and the

■ **Fig. 13:** *Post-treatment facial and intraoral photographs*

■ *Fig. 14:*
Superimposed cephalometric tracings show the dentofacial changes after 19 months of active treatment (Pre-Tx: black; Post-Tx: red). The tracings are superimposed on the anterior cranial base (left), maxilla (upper right), and mandible (lower right). See text for details.

alignment of both arches was achieved with progressive 0.014x0.025-in CuNiTi and 0.017x0.025-in TMA archwires. In the 10th and 11th months, more rigid 0.016x0.025-in SS archwires were employed in the maxillary and mandibular lower arches for the remaining space closure.

To close the extraction spaces, four-ring power chains were applied bilaterally, from U3s to U6s in the maxilla. Simultaneously, Class II elastics (Fox, 1/4-inch, 3.5-oz; Ormco) were applied bilaterally from U3s to L6s and L7s.

In the 17th month, black triangles were noted interproximally between the four upper incisors. Interproximal enamel reduction (IPR) was performed from UR2 to UL2 in the 17th month (Fig. 10) and from LR3 to LL3 in the 18th month of treatment, respectively. Figure-of-eight ties were subsequently applied in both arches.

Following 19 months of active treatment, the removal of all fixed appliances took place. Subsequently, post-treatment records, including casts, photographs, as well as panoramic and lateral cephalometric radiographs, were obtained. (Figs. 13-17).

Result Achieved

The severe crowding and anterior crossbite were successfully corrected after 19 months of active

■ *Fig. 15:* Posttreatment cephalometric radiograph

■ *Fig. 16:* Posttreatment panoramic radiograph

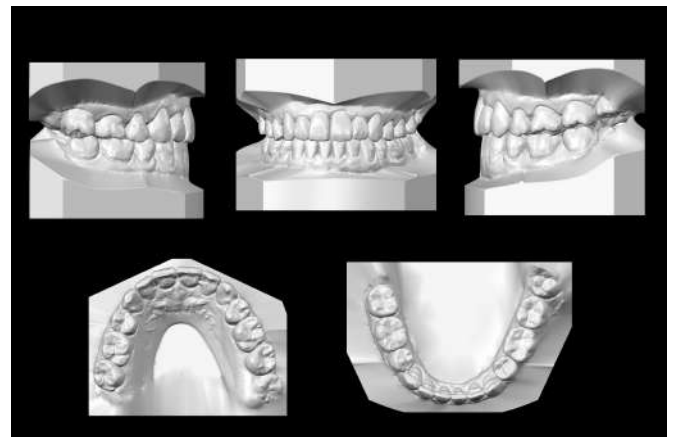■ *Fig. 17:* Posttreatment dental models (intraoral scanning)

treatment (Fig. 13). The extraction spaces were fully closed, and the canine and molar relationships were corrected to Class I relationships.

The superimposed cephalometric tracings illustrate that the axial inclination of the upper incisors (U1-SN) decreased 5.5˚ after treatment (115.5˚ to 101˚), but the lower incisors (L1-MP) were unavoidably tipped lingually due to space closing. (90.5˚ to 78˚) (Fig. 14; Table 1).

The upper and lower lips were both retruded following the retraction of the anterior segments. The mandibular plane angle (SN-MP) was well-maintained. The Cast-Radiograph Evaluation (CRE) score was 24 points, as shown in the supplementary Worksheet 2.[6] The Pink and White dental esthetic score was 2 points (Worksheet 3).[7] The patient was pleased with the final result.

Retention

After the fixed appliances were removed, two ESSIX® (Dentsply Sirona, Harrisburg, PA) overlay retainers were provided to retain the alignment of the dentition. Fixed retainers were also placed from UR2 to UL2 on the upper arch, and from LR3 to LL3 on the lower arch to prevent the crowding from relapsing.

Discussion

Extraction or Non-extraction

The primary issue for this patient was overcrowding in the anterior teeth. The patient presented with a concave profile, flared anterior teeth, and severe crowding exceeding 7 mm. Following Chang's Extraction Decision Table (Table 2), a treatment plan was devised, which involved the extraction of all four first premolars to alleviate the crowding and facilitate the retraction of the anterior teeth, aiming for an optimal esthetical and functional outcome.

Brackets torque selection: Consider Class II elastics and space closure.

High-torque brackets were selected for the upper and lower canines to prevent their roots from striking the buccal cortical bone and causing problems related to space closure.

The initial condition of the U1s was proclined and protruded, whereas the L1s were initially flat. To address the proclination of the U1s and the flat L1s, Class II elastics were employed during the closure of the extraction spaces. This approach aimed to retract and recline the U1s while also flare out the L1s. Taking the available mechanics into consideration, standard-torque brackets were selected for both the upper and lower incisors to achieve the aimed effects.

However, upon reviewing the posttreatment cephalometric radiograph, it was observed that during the first premolar extraction space closure,

the lower incisor angle (L1→MP) decreased excessively (90.5° to 78°), which was less than ideal. If we were to reconsider the treatment plan, the use of high-torque brackets for the lower incisors might have been a more suitable choice.

Alternatively, introducing Class II elastics at an earlier stage could also be considered. If Class II elastics were introduced earlier, the mechanics could cause further flaring of the lower anterior teeth and simultaneously straighten the upper anterior teeth.

Anterior crossbite correction

Anterior crossbite is a malocclusion characterized by the maxillary anterior teeth being positioned lingually in comparison to the mandibular anterior teeth. In the current case, the patient's anterior crossbite resulted from insufficient space in the maxilla to accommodate the upper lateral incisors.

Following the extractions, brackets were bonded on all upper teeth except for U2s. To create space for U2s, an open coil spring was introduced bilaterally between U1s and U3s. It is advisable to leave U2s unengaged from the archwire during this space-opening phase to allow them to remain as free bodies. Once sufficient space was created by the open coil spring, the U2s were bonded and engaged with the archwire for alignment and leveling.

Black triangle management

Interproximal reduction (IPR) of the enamel is a common technique used in orthodontic

treatments to create additional space for alignment.[9,10] Followed by space consolidation with power tubes, IPR helps increase the length of interproximal contacts and reduces the presence of black triangles.

In this case, since a black triangle was observed, IPR was carried out to enhance both alignment and esthetics. Figure-eight ties were applied on both arches in order to maintain space consolidation between the anterior teeth.

Conclusions

This Class I malocclusion, complicated by severe crowding, an anterior crossbite, and protruding anterior teeth, was successfully treated to a pleasing result. The decision on whether to extract or not was guided by Chang's Extraction Decision Table, which provided a well-defined and structured guideline. In cases involving extractions, torque selection is a pivotal factor influenced by various considerations, which plays a crucial role in achieving a successful outcome.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE   **12**

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   =   **4**

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. _____ pts. additional

Total   =   **0**

LINGUAL POSTERIOR X-BITE

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

BUCCAL POSTERIOR X-BITE

2 pts. Per tooth   Total   =   **0**

CEPHALOMETRICS   (See Instructions)

ANB $\geq 6°$ or $\leq -2°$	= 4 pts.
Each degree $< -2°$_____ x 1 pt.	= _____
Each degree $> 6°$ _____ x 1 pt.	= _____
SN-MP	
$\geq 38°$	= 2 pts.
Each degree $> 38°$_____ x 2 pts.	= _____
$\leq 26°$	= 1 pt.
Each degree $< 26°$_____ x 1 pt.	= _____
1 to MP $\geq 99°$	= 1 pt.
Each degree $> 99°$ _____ x 1 pt.	= _____

Total   =   **0**

OTHER   (See Instructions)

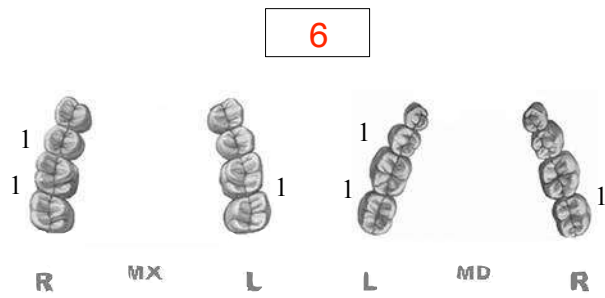|		
Supernumerary teeth	_____ x 1 pt.	=_____
Ankylosis of perm. Teeth	_____ x 2 pts.	=_____
Anomalous morphology	_____ x 2 pts.	=_____
Impaction (except 3rd molars)	_____ x 2 pts.	=_____
Midline discrepancy ($\geq$ 3mm)	@ 2 pts.	=_____
Missing teeth (except 3rd molars)	_____ x 1 pt.	=_____
Missing teeth,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

Identify:

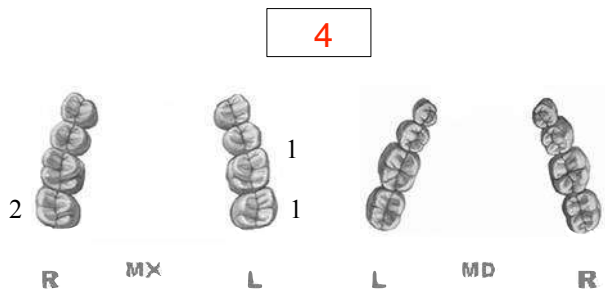Total   =   **0**

Cast-Radiograph Evaluation

Total Score: 24

Occlusal Contacts

8

2   1 2 2 1

Buccal Surface

Lingual Surface

Alignment/Rotations

3

1

2

R   MX   L   L   MD   R

Marginal Ridges

6

1
1   1   1   1
      1   1   1

R   MX   L   L   MD   R

R   L

R   L
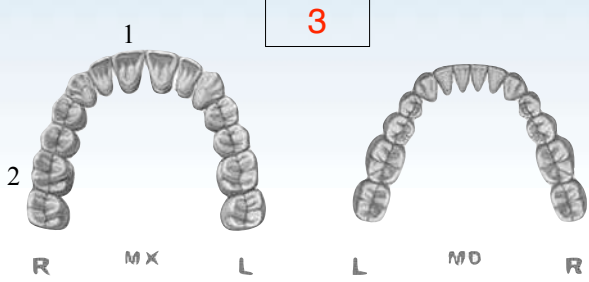
Buccolingual Inclination

4

2
     1
     1

R   MX   L   L   MD   R
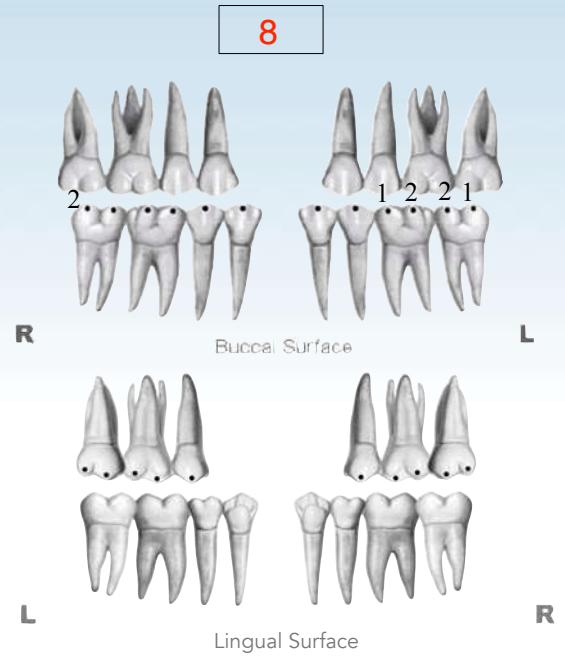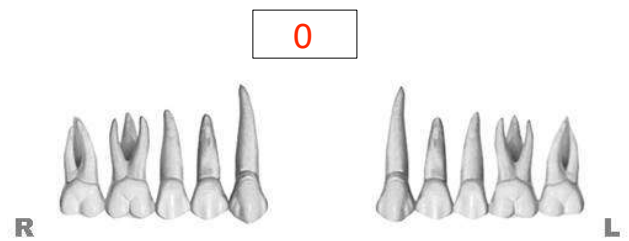
Interproximal Contacts

R   L

Overjet

1

1

R   MX   L

Root Angulation

2

1   1

R   L
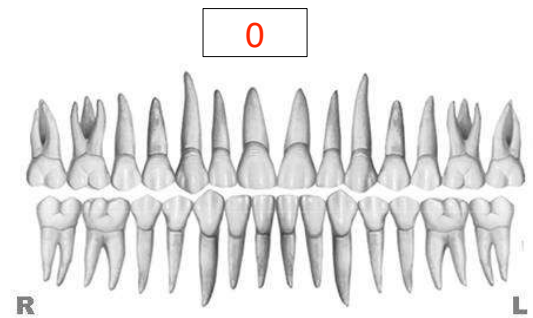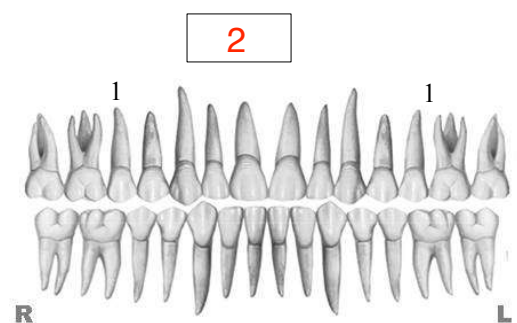
INSTRUCTIONS: Place score beside each deficient tooth in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score
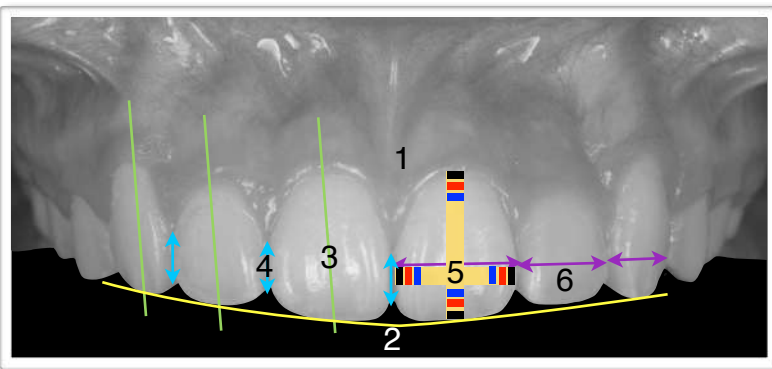
Total Score = `2`

1. Pink Esthetic Score

Total = `1`

	0	1	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 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

2. White Esthetic Score (for Micro-esthetic)

Total = `1`

	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	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	(0)	1	2
6. Tooth to Tooth Proportion	(0)	1	2

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

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

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Screws & Aligners

Nov 26-28

Keynote (optional)

Nov 29

Course fees*:

Day 123	USD **3,950** (Early bird rate*)	USD 4,600
Day 4	USD **500** (Early bird rate*)	USD 700

* Fees cover local transportation, meals and three nights of shared accommodation (double occupancy). Airport pick up is available upon request with additional charges.

* Early bird rate ends two months prior to the course date.

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

> *"Dr. Angle would be glad to know that contemporary orthodontics has a professional as Chris Chang!"*
>
> Prof. Dr. Paulo Fernandes Retto, Portugal

Dr. Chang 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.

IMPACTION

📅 Course Schedule

DAY 1 — **Chair-side observation**

DAY 2 — **Lecture, chair-side observation**
Lecture topic: Screws & Aligners

DAY 3 — **VISTA & 4 other minor surgeries for orthodontic practice**
Hands-on workshop

DAY 4 — **Keynote workshop**
(optional) conducted by Newton's A team

IZC Screw
2x14 SS w **hole** +
3D lever arm (19x25SS)

VISTA ✓
Vertical Incision Subperiosteal Tunnel Access

2024

一年一度
Damon Master Program

全新改版的 2024 年貝多芬高效 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，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 - 3/28

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（黃亭雅, 陳韻如醫師）

Module 2 - 4/11

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

Practice: Patient photo management（金牛頓工程師）

Module 3 - 4/25

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

Practice: Ceph tracing（金牛頓工程師）

Module 4 - 5/16

1. Excellent finishing
2. Retention & relapse

Practice: Ceph superimposition & measurement（金牛頓工程師）

Module 5 - 5/30

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

Practice: Case report demo（陳俊宏醫師）

▲ Computer training (Mac): 1:30-3:00 pm

Module 6 - 6/20

1. Class III correction
2. Class II correction

Topic: Early orthodontic treatment（曾淑萍醫師）

Module 7 - 6/27

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

Topic: Modified VISTA（蘇筌瑋醫師）

Module 8 - 7/11

1. ABO DI, CRE workshop (林彥君醫師)
2. Open bite

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

Module 9 - 7/25

1. Implant-ortho combined treatment
2. Asymmetry

Topic: Impacted cuspid treatment（張譯文, 張瑜珍, 黃亭雅, 陳韻如醫師）

Module 10 - 8/29

1. Minor surgeries in orthodontics
2. Digital orthodontics

Topic: Modified 2X4 appliance in ortho treatment（李亮賢醫師）

Module 11 - 9/19

1. Aligner design
2. Comprehensive aligner treatment
3. Aligner & its challenges

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。
*贈送之課程視訊提供兩年時間串流觀看。

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