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

Abstract

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

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

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

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

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

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

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

History and Etiology

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

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

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

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

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

of the mandible. Smile analysis revealed a slight gummy smile in the buccal regions. Crowding was 6mm in the upper arch and 3mm in the lower. The panoramic radiograph (*Fig. 2*) revealed a moderate loss of alveolar crest height in the upper and lower anterior segments. The temporomandibular joint (*TMJ*) function was within normal limits. There was no history of pain. Retrusive posturing of the mandible in maximum interdigitation was due to posterior deflection of the right lateral incisors (*Fig. 1*). A lateral cephalometric radiograph confirmed mandibular retrusion (*SNA 82˚, SNB 78˚, and ANB 4˚*) that was associated with a steep mandibular plane angle (*SN-MP 36˚*). The lower incisors were labially inclined (*L1-MP 98˚*) and both lips were retrusive (*-4mm/-1mm to the E-Line*) (*Fig. 2*). An intraoral scan of the malocclusion is shown in Fig. 3. The ABO Discrepancy Index (*DI*)[1] was 16 points as shown in the subsequent worksheet. Similar to a previous complex malocclusion treated with clear aligners,[2] the pattern of attachments was carefully planned (*Fig. 4*) to achieve a pleasing outcome (*Fig. 5*). Clincheck® details contributed to an excellent final occlusion (*Figs. 6 and 7*). Radiographic documentation of the
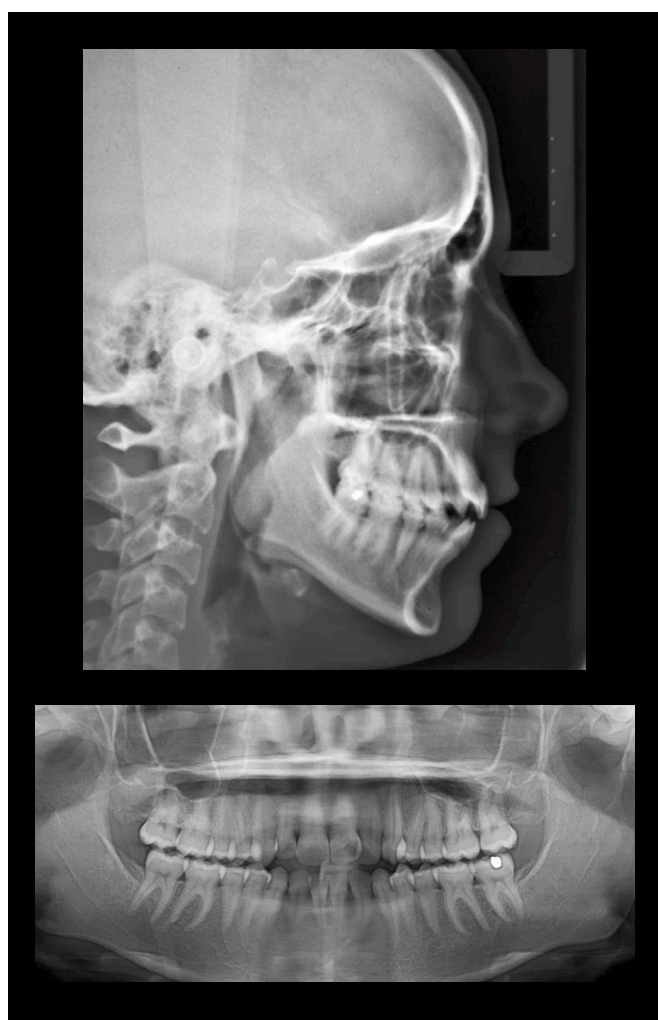
■ *Fig. 2:*
*Pre-treatment lateral cephalometric and panoramic radiographs*
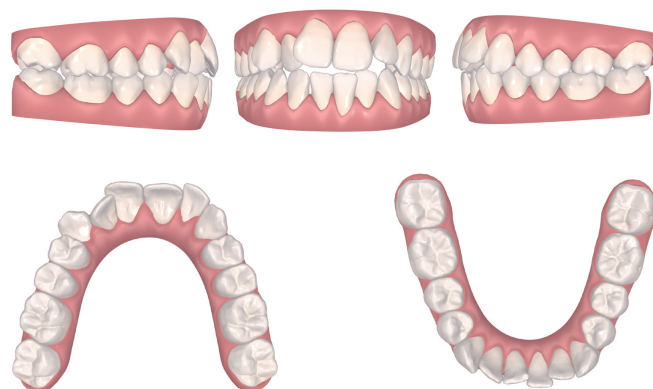
■ *Fig. 3:*
Images captured by iTero intraoral scanner at the start of the treatment.
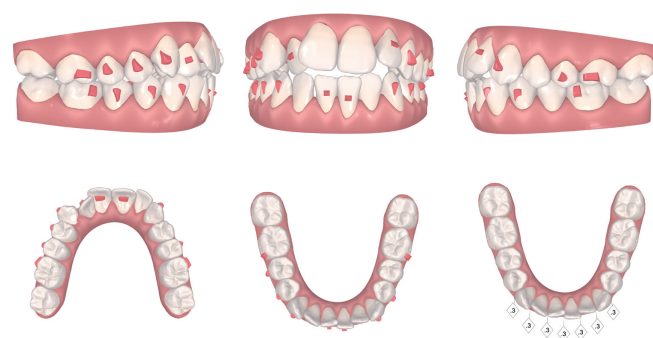
■ *Fig. 4:*
After 20 days of treatment with two initial aligners, different attachments are selected to move teeth in accordance with the treatment goals.

Fig. 7: Clincheck® Final outcome



Fig. 5: Post-treatment facial and intraoral photographs
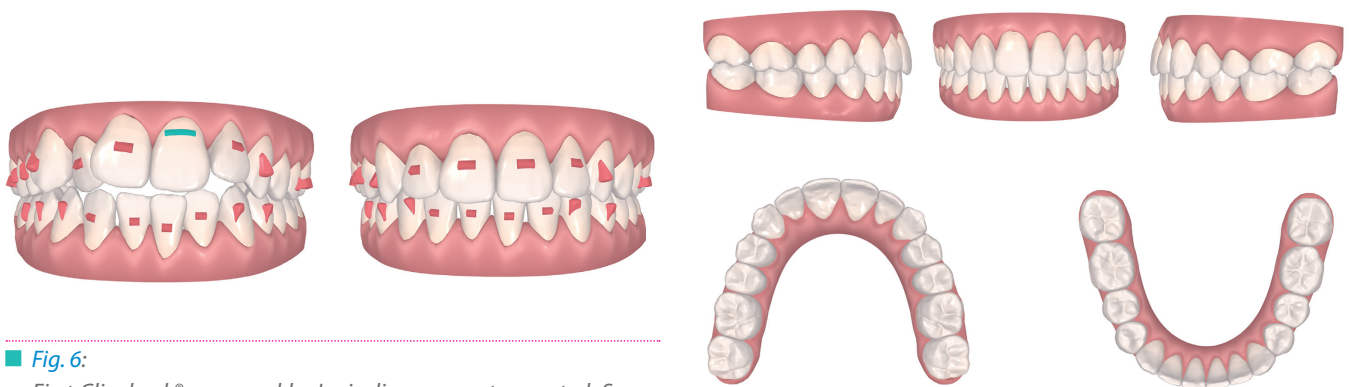
Fig. 6:
First Clincheck® proposed by Invisalign was not accepted. Seven modifications were made including extrusive movement for only in lateral incisors to level them with central incisors. Central incisor attachments were removed to improve aesthetics.

Fig. 7: Clincheck® Final outcome

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

Etiology

Consideration of the etiology is an important prerequisite for designing an efficient treatment plan with good potential for stability. This acquired malocclusion[3] reflected inadequate arch width development, due to the reduced occlusal loading (*soft diet*) during childhood.[4,5] The anterior open bite is consistent with low tongue posture associated with nocturnal airway deficiency[6] and/or non-nutritive sucking habits.[7] Low tongue posture is common during the childhood years when the pharyngeal lymphoid tissue is hypertrophied. Inadequate development of the mandibular elevator muscles[8,9] is associated with excessive facial height (*Fig. 1*). Since the major etiologic factors for arch constriction occurred in childhood, bimaxillary arch expansion was indicated to achieve appropriate
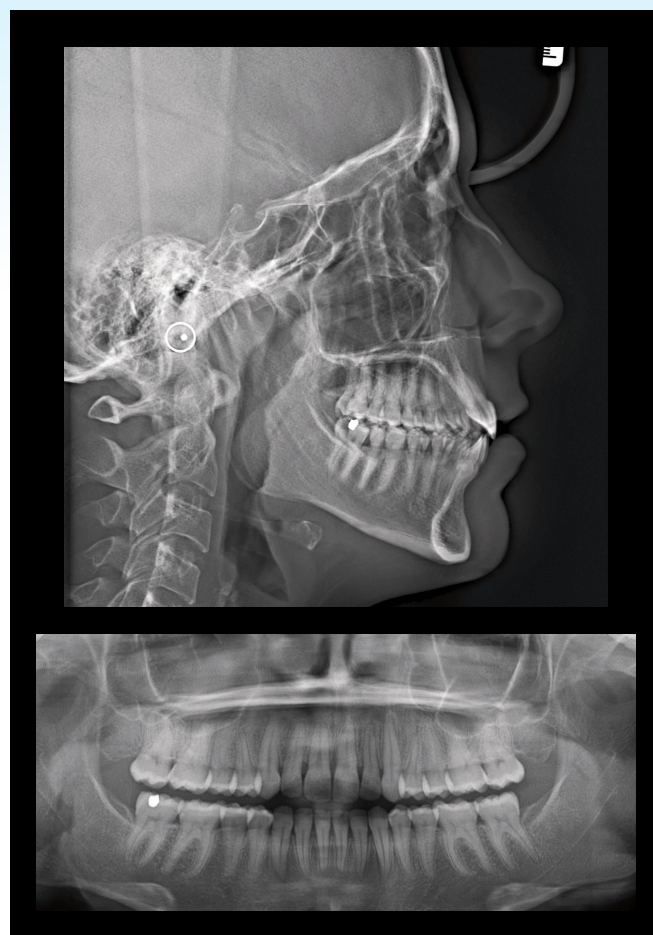
■ *Fig. 8:*
Post-treatment lateral cephalometric and panoramic radiographs
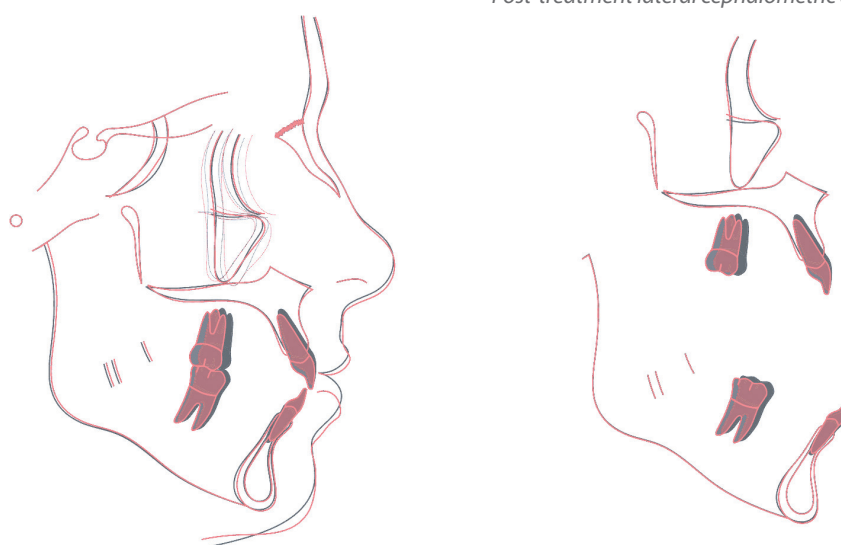
■ *Fig. 9:*
Superimposed cephalometric tracings show dentofacial relationships before (black) and after (red) treatment. Anterior cranial base superimposition on on the left. The maxillary and mandible superimpositions are on the upper right and lower right, respectively.

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

Treatment Objectives

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

1. Align, level, and expand the dentition of both dental arches.[10]

2. Correct the canine and molar Class II malocclusion.[11,12]

3. Eliminate the open bite and provide proper overbite by eliminating the functional, mandibular retrusion and allowing the mandible to posture more anteriorly.

4. Resolve crowding arches expansion and enamel stripping as needed.

5. Improve the esthetics of the smile.[13,14]

6. Expand the maxillary arch to improve the posterior gummy smile.

7. Coordinate the dental midlines with incisor alignment and differential enamel stripping as needed.

Maxilla (all three planes):

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

Mandible (all three planes):

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

Maxillary Dentition

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

Mandibular Dentition

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

Facial Esthetics

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

Treatment Plan

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

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

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

Appliances and Treatment Progress

The Invisalign® System was used for intermaxillary treatment as previously described.[17,18] For the prescribed treatment, a total of 47 aligners were used, supplemented with Class II elastics (*3/16-in 6½-oz*) for at least 20 hours per day. The latter were attached through slits in the aligners from stage 26. Treatment began when the first two aligners were delivered to the patient with instructions to wear them 10 days each for 22 hours a day. The aligners were removed only for eating and brushing. The

two initial aligners were programmed for expansion and labial tipping, but not extrusion or rotational movements. At the second appointment on day 20, attachments were bonded on the dentition (*Fig. 4*) with Tetric EvoCeram (*Ivoclar Vivadent, Inc. NY, USA*) according to the following prescription.

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

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

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

- 3.6 Vertical 3mm, precision cut for elastics

- 3.4 Optimized for rotation

- 3.3 Optimized for rotation

- 3.1 Optimized for extrusion

- 4.6 Vertical 3mm, precision cut for elastics

- 4.5 Optimized for rotation

- 4.4 Optimized for rotation

- 4.3 Optimized for rotation

- 4.1 Optimized for extrusion

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

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

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

Results achieved

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

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

■ *Table 1: Cephalometric summary*

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

Maxilla (all three planes):

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

Mandible (all three planes):

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

Maxillary Dentition

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

Mandibular Dentition

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

Retention

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

Discussion

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

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

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

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

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

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

Conclusion

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

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

Acknowledgement

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Discrepancy Index Worksheet

TOTAL D.I. SCORE   16

OVERJET

0 mm. (edge-to-edge)	=	
1 – 3 mm.	=	0 pts.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	3 pts.
7.1 – 9 mm.	=	4 pts.
> 9 mm.	=	5 pts.

Negative OJ (x-bite) 1 pt. per mm. per tooth   =

Total   =   **2**

OVERBITE

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

Total   =   **0**

ANTERIOR OPEN BITE

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

Total   =   **8**

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total   =   **0**

CROWDING (only one arch)

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

Total   =   **4**

OCCLUSION

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

Total   =   **2**

LINGUAL POSTERIOR X-BITE

1 pt. per tooth   Total   =   0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth   Total   =   0

CEPHALOMETRICS   (See Instructions)

ANB $\geq$ 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 pts. =	___
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. =	___

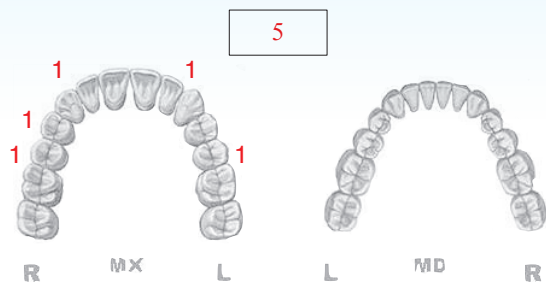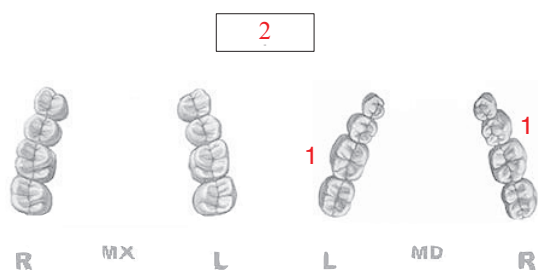Identify:

Total   =   0

Cast-Radiograph Evaluation

Occlusal Contacts

2

Case # **Patient**

Total Score: **15**

Alignment/Rotations

5

1   1

1

1   1

MX   L   L   MD   R
R

Buccal Surface

1   1

Lingual Surface
L   R

Marginal Ridges

2

1

1   1

R   MX   L   L   MD   R

Occlusal Relationships

0

R   L

Buccolingual Inclination

2

1   1

R   MX   L   L   MD   R
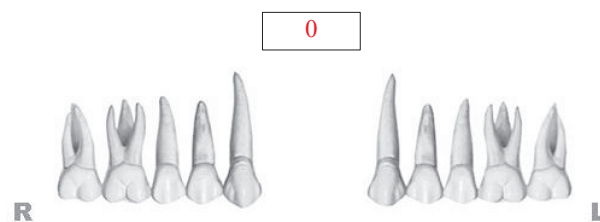
Interproximal Contacts

0

R   L

Overjet

0

R   MX   L
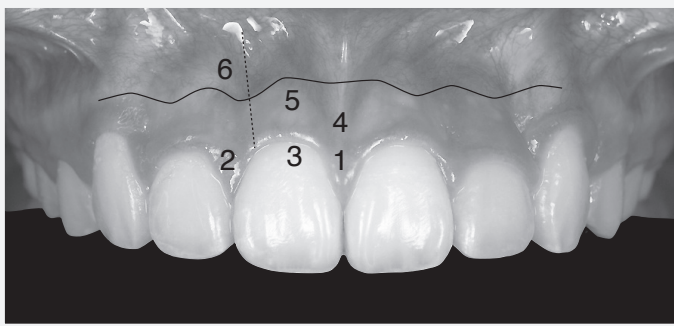
Root Angulation

4

2   2

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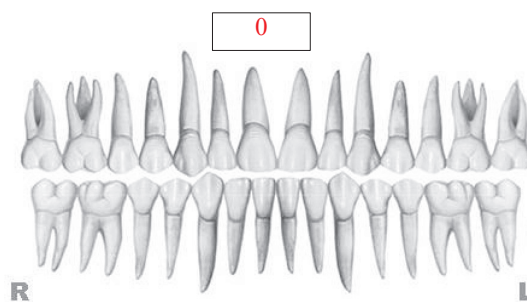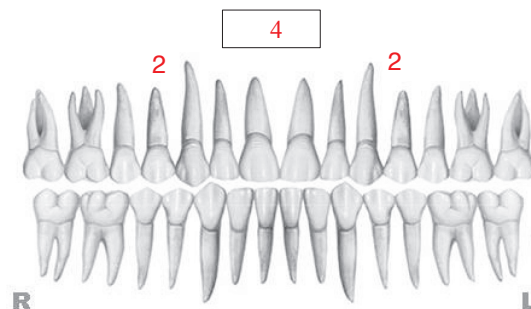
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

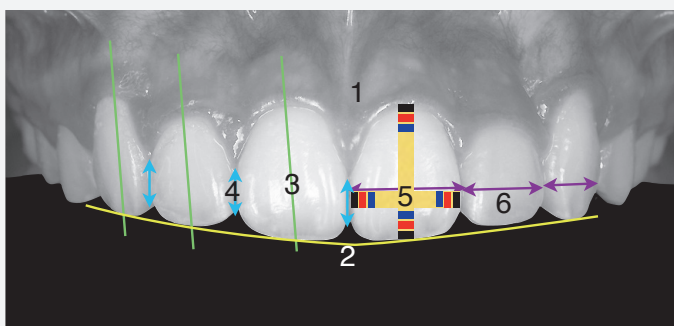# IBOI Pink & White Esthetic Score

Total Score: = | 3 |

Total = | 1 |

1. Pink Esthetic Score

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

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

2. White Esthetic Score (for Micro-esthetics)

Total = | 2 |

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

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