Non-extraction Treatment of Severe Anterior Crowding

History and Etiology

A 21-year-10-month old female presented for orthodontic consultation. Her chief complaint was the irregularity of her teeth (*Figs. 1-3*). There was no contributing medical or dental history. Her oral hygiene was good, and temporomandibular function was within normal limits (*WNL*).

Fig. 1: Pretreatment facial photographs

The initial clinical examination revealed severe anterior crowding in both arches. The etiology of the malocclusion was deemed to be a space deficiency due to relatively narrow arches. The patient was treated to a near ideal outcome, as documented in Figs. 4-6. The diagnosis and treatment are documented with pre-treatment (*Fig. 7*) and post-treatment (*Fig. 8*) panoramic and cephalometric radiographs, as well as superimpositions cephalometric tracings (*Fig. 9*).

Fig. 2: Pretreatment intraoral photographs

Diagnosis

Skeletal:

- Class III pattern (*SNA 80°, SNB 81°, ANB -1°*)
- Decreased mandibular plane angle (*SN-MP 28°, FMA 21°*)
- Both dental arches were relatively narrow

Dental:

- Right Occlusion: Class I molar, Class II canine

Fig. 3: Pretreatment study models

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Fig. 4: Posttreatment facial photographs

Fig. 5: Posttreatment intraoral photographs

Fig. 6: Posttreatment study models

- Left Occlusion: End on Class II molar, Class II canine
- OB 4 mm; OJ 6 mm
- Crowding: 10 mm in the upper arch and 8mm in the lower arch
- Upper incisors were tipped labially. (*U1-SN 118°*)
- Lower incisors were tipped lingually. (*L1-MP 86°*)
- Both lower third molars were impacted

Facial:

- Straight profile with decreased but acceptable lip position
- UL-E line: -1.5mm
- LL-E line: -1.5mm

The IBOI discrepancy index (*DI*), which is derived from the American Board of Orthodontics (*ABO*) method (*http://www.americanboardortho.com/professionals/ clinicalexam/*), was 14 as shown in the subsequent work sheet. The most important diagnostic factors were the excessive overjet and anterior crowding (*Fig. 10*).

Specific Objectives of Treatment

Maxilla (*all three planes*):

- A - P: Maintain
- Vertical: Maintain

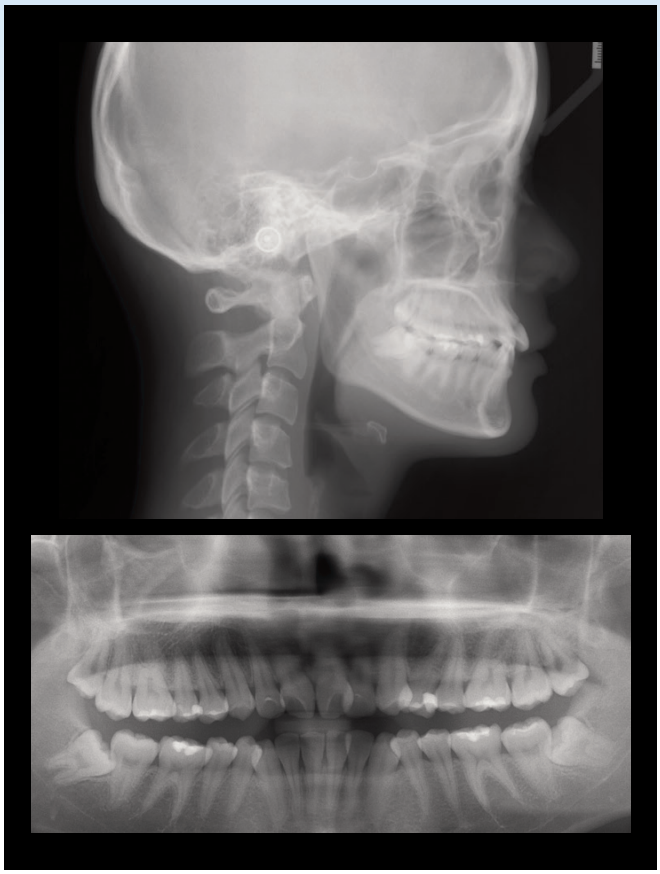


Fig. 7: Pretreatment pano. and ceph. radiographs

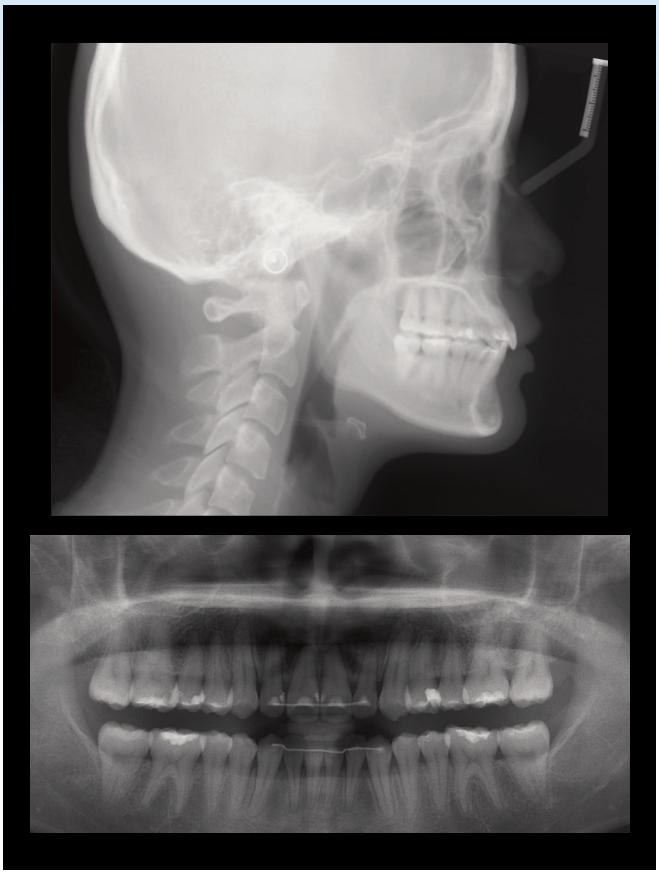


Fig. 8: Posttreatment pano. and ceph. radiographs

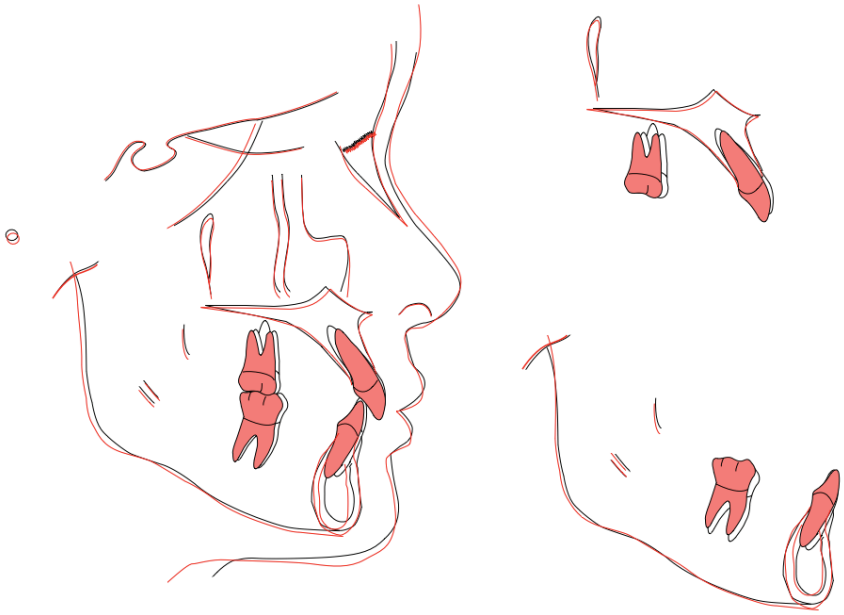


Fig. 9: Superimposed tracings

Fig. 10: The major diagnostic factors were a 6mm overjet and severe crowding in both arches.

- Transverse: Maintain

Mandible (*all three planes*):

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

Dentition:

- Maxillary: Correct incisal inclination, crowding and narrow arch width
- Mandibular: Correct incisal inclination, crowding, and the lingually inclined buccal segments
- Intermaxillary: Correct the left Class II molar relationship

Facial Esthetics: Maintain

Treatment Plan

All four third molars were extracted before initiating orthodontic treatment. Considering the patient's marginally retrusive lip position, a nonextraction (*other than third molars*) treatment plan with fixed appliances was indicated to resolve the crowding. Damon D3MX brackets (*Ormco*), with an .022" slot, were selected because this light force, self-ligation system can increase arch width and create space for correcting the crowding. This method is particularly effective for patients with a narrow arch form. All upper and lower incisors were bonded with low torque brackets. Interproximal reduction (*IPR*) of the enamel on the lower incisors was indicated to avoid flaring of the lower anterior teeth. Class II elastics were used to resolve the sagittal occlusion discrepancy, and detailing bends and settling elastics produced the final occlusion. The fixed appliances were removed and the corrected dentition was retained with anterior fixed retainers on both arches, and a clear overlay retainer on the upper arch.

Appliances and Treatment Progress

After the extraction of all four third molars, a .022" slot Damon D3MX® appliance (*Ormco*) was bonded on all teeth in both arches. Low torque brackets were used for all the incisors. The maxillary arch was bonded first (*Fig. 11*), and one month later the lower arch was initiated (*Fig. 12*). The wire sequences were identical for both arches: .014 CuNiTi, .016 CuNiTi, .014x.025 CuNiTi, and .017x.025 low friction TMA. In the 14th month of treatment, a .019x.025 De-Q (*-20°*) wire was used in the upper arch to enhance the torque control of the incisors (*Fig. 13*), and IPR was performed on the lower incisors to provide crowding relief and to prevent lower anterior flaring (*Fig. 14*).

Fig. 11:

Upper arch was bonded with .022" slot Damon D3MX® brackets. Low torque brackets were chosen for the incisors.

Fig. 12:

Lower arch was bonded with Damon D3MX® brackets. Low torque (-6°) brackets for the incisors played a role in the torque control.

Fig. 13:

The .019x.025 De-Q (-20°) wire was used in the upper arch to enhance the torque control of the anterior teeth.

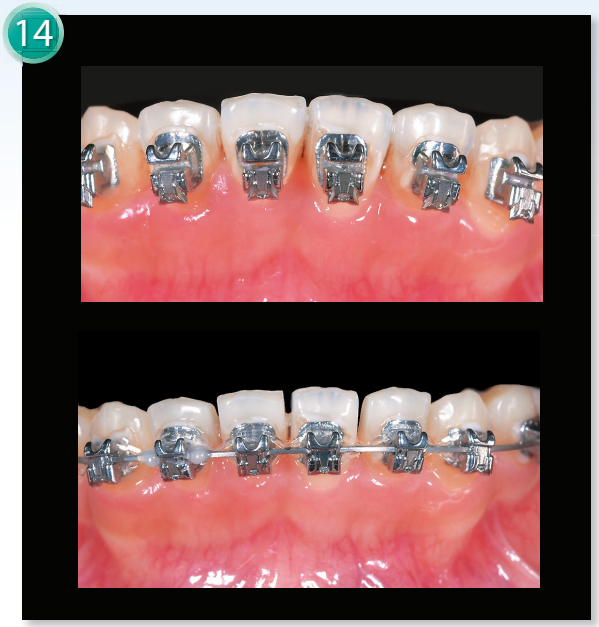


Fig. 14:

The lower incisors were stripped to provide crowding relief and to prevent the anterior flaring out.

In the 19th month, bracket positions were corrected for the upper right central incisor and canine. Torquing springs (*.018X.025*) were placed on both upper canines to apply labial root torque. In the 22nd month, torquing springs for the labial root torque of the upper canines continued, and Class II elastics were included to improve the molar relationship (*Fig. 15*). From the 24th month, up and down triangle elastics (*4.5oz*) were used in the canine regions for final detailing of the anterior segments (*Fig. 16*).

After 26 months of active treatment, the appliances were removed. Before and after treatment casts documented arch expansion in both the maxillary (*Fig. 17*) and mandibular (*Fig. 18*) arches. Anterior fixed retainers were bonded on both arches as follows: 2-2 in the upper and 3-3 in the lower. A clear overlay retainer was delivered for the upper arch, and a

Fig. 15:

Torquing springs (.018X.025) were placed on both upper canines for torque control. Class II elastics were included to improve the molar relationship.

Fig. 16:

The up and down elastics (4.5oz) were used anteriorly for final detailing of the anterior segments.

gingivectomy was performed on the upper lateral incisors with a diode laser to improve the crown length-to-width proportion (*Fig. 19*).

Results Achieved

Maxilla (*all three planes*):

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

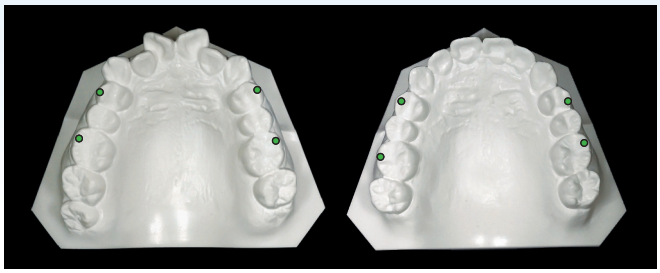


Fig. 17:

In the upper arch : the inter-premolar width was increased 5mm and the inter-molar width was increased 4mm.

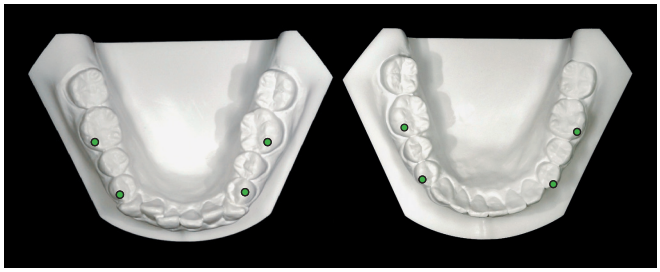


Fig. 18:

In the lower arch, the same amount of width was increased as in the upper arch.

Fig. 19:

The gingival display of the upper lateral incisors was improved by gingivectomy .

Mandible (*all three planes*):

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

Maxillary Dentition:

- A - P: Improved the axial inclination of the upper incisors (*118°to 110°*)
- Vertical: Maintained
- Inter-premolar width: Increased 5mm (*39.5mm to 44.5mm*)
- Inter-molar width: Increased 4mm (*49mm to 53mm*)

Mandibular Dentition:

- A - P: Increased the axial inclination of lower incisors (*86° to 93°*)
- Vertical: Maintained
- Inter-premolar width: Increased 5mm (*30mm to 35mm*)
- Inter-molar width: Increased 4mm (*42mm to 46mm*)

Facial Esthetics: Maintained

Retention

As previously described, fixed retainers were bonded on all maxillary incisors and from canine to canine in the mandibular arch. An upper clear overlay retainer was delivered. The patient was instructed to wear it full time for the first 6 months and nights only indefinitely. Instructions for home care and maintenance of the retainers were also provided.

Gingival Display

Following removal of the fixed appliances and the post-treatment recovery of the gingival contours, the maxillary lateral incisors had excessive gingival display. Adjusting the gingival esthetics, particularly for teeth in the esthetic zone (*maxillary anterior region*) must be approached carefully. The gingival sulcus of the upper lateral incisors was probed and the average depth on the labial surface was 4mm. Deducting 2mm for the biological width of the epithelial attachment and 1mm for the desired sulcus depth, a 1mm gingivectomy with a diode laser was deemed appropriate to improve the tooth proportions and gingival display. Fig. 19 shows the gingival display on the maxillary lateral incisors before and after gingivectomy.

Final Evaluation of Treatment

The Cast-Radiograph Evaluation score (*http://www.americanboardortho.com/professionals/clinicalexam/*) was 21 points as shown in the subsequent work sheet. The major discrepancies were the buccolingual inclination (*6 points*), uneven marginal ridges (*5 points*) and root angulation (*4 points*). The IBOI pink and white esthetic score was 4.

The molar and canine relationship are both Class I. Both overbite and overjet were ideal. Upper incisor to the SN angle decreased from 118° to 110°. The Lower incisor to the Md plane angle increased from 86° to 93°. Lip protrusion increased in both arches: UL-E line increased from -1.5mm to -1mm, LL-E line increased from -1.5mm to -0.5mm. As previously described, arch widths increased 4-5mm in both arches (*Figs. 17-18*).

The patient's chief concern (*crowding*) was resolved. A good intermaxillary alignment was achieved consistent with optimal esthetics. Overall, the treatment results were pleasing to both the patient and the clinician.

Discussion

Deciding on extraction or non-extraction treatment is often perplexing, especially in borderline cases. The principal consideration is how to create space to correct crowding without adversely affecting the facial profile. Proffit, Fields and Sarver[1] concluded that arch expansion, without moving the incisors anteriorly, was the most critical factor in achieving a satisfactory resolution of crowding without extractions.

The diagnosis was performed according to the Chang[2] criteria for "Crowding: Ext. vs. Non-ext." A non-extraction approach was indicated due to the straight profile, relatively retrusive lips, and low mandibular plane angle. However 8-10 mm of crowding in each arch, and the anteriorly inclined upper incisors, were a challenge to manage. The current approach focused on gaining space while controlling the axial inclinations of the anterior teeth.

The Damon passive self-ligation system provides a good mechanism for gaining space via posterior transverse arch adaptation. Dwight Damon proposed: "*With light forces in a passive system, the posterior transverse arch adaptation results from interplay among the tongue, the alignment forces and the resistant lip musculature. Working in conjunction, they encourage the teeth to follow the path of least resistance, which is posterolaterally.*" Bagden[3] pointed out that the additional arch width that is gained by this process produces the space required to resolve most crowded dentitions without extractions, molar retraction or rapid palatal expansion. In the present case, the narrow arch forms were widened in both arches. Arch expansion was 5mm in the premolar and 4mm in the molar regions, respectively. Excellent alignment was achieved and the result was stable 3 years later, at a follow-up examination (*Figs. 20-22*).

To supplement arch expansion, space was also created with interproximal enamel reduction (*IPR*).[4] It was performed on the lower incisors in the 14th month to prevent labial flaring.[5] Despite arch expansion and IPR, the lower incisor to the Md plane angle increased from 86° to 93°. This result was expected because of the severe dental crowding initially; however, a lower anterior fixed retainer was deemed necessary for long-term stability of the lower incisor alignment.

Fig. 20: Posttreatment facial photographs (3 years follow up)

Fig. 21:
Posttreatment intraoral photographs (3 years follow up)

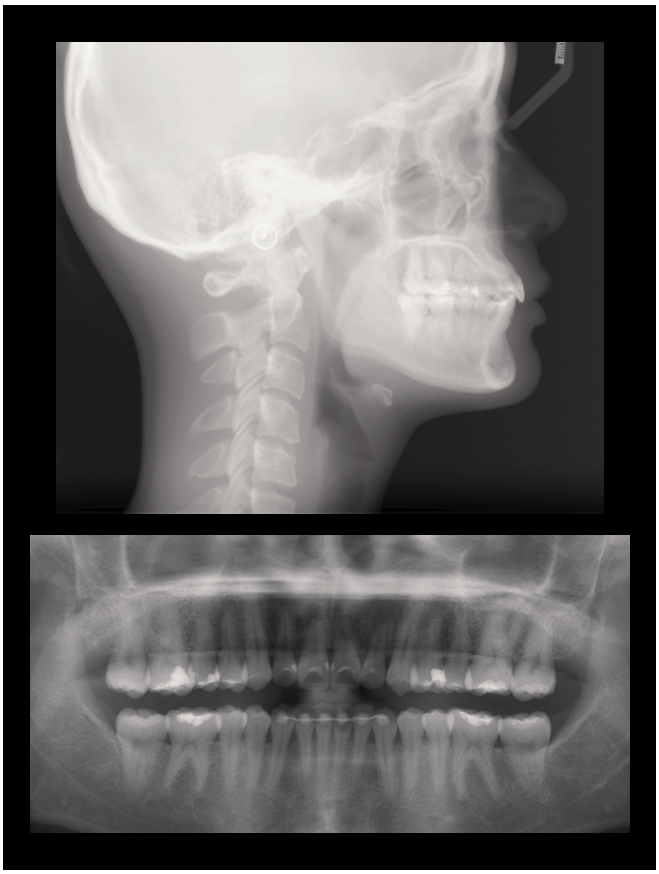


Fig. 22:
Posttreatment pano and ceph radiographs
(3 years follow up)

Kozlowski[6] has emphasized the following important principle: "*Match Torque Selection to Case Goals.*" Utilizing the variable torque options of the Damon System, treatment time can be shortened while enhancing stability. Because of the severe anterior crowding and anteriorly tipped incisors in the maxillary arch, the low torque brackets on the upper incisors were engaged with a .019X.025 De-Q (*-20°*) archwire to provide additional torque control in the 14th month. Combined with the retraction force of the CII elastics, the axial inclination of the maxillary incisors improved from118° to 110°. Bone screws anchorage was not applied. Additional compensations for the maxillary anterior flaring were torquing springs (*.018X.025 SS*) which were applied to the upper canines to enhance labial root torque. The low torque (*-6°*) brackets on lower incisors were effective in helping control axial inclinations.

The IBOI Cast-Radiograph Evaluation, which is based on the ABO method,[7] was 21; most of the points deducted were for discrepancies of the buccolingual inclination, marginal ridge alignments and root angulation. It appears that the majority of

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	80°	80°	0°
SNB°	81°	80°	1°
ANB°	-1°	0°	1°
SN-MP°	28°	29°	1°
FMA°	21°	22°	1°
DENTAL ANALYSIS			
U1 TO NA mm	4 mm	3 mm	1 mm
U1 TO SN°	118°	110°	8°
L1 TO NB mm	0.5 mm	1 mm	0.5 mm
L1 TO MP°	86°	93°	7°
FACIAL ANALYSIS			
E-LINE UL	-1.5 mm	-1 mm	0.5 mm
E-LINE LL	-1.5 mm	-0.5 mm	1 mm

■ Table. 1: Cephalometric summary

these residual problems could have been corrected if they had been identified with prefinish records: casts and a panoramic radiograph obtained about 6 months before the anticipated debonding date. When finishing problems are known, most can be systematically eliminated in the last few months of treatment.[8]

Conclusion

When choosing a non-extraction approach for resolving severe anterior crowding, the most critical consideration is to choose a method for gaining space that does not produce excessive flaring of the incisors. The Damon System offers an efficient way to gain space by using light forces that are within the functional adaptation capability of the oral cavity. Furthermore, anterior torque control and interproximal stripping of enamel is also helpful for achieving a pleasant result. Resolving the problem for the patient satisfactorily, without any undesirable side effects, should be the guiding principle.

Acknowledgment

Thanks to Dr. Roberts for proofreading this article.

References

1. Proffit WR, Fields HW, Jr, Sarver DM. Contemporary Orthodontics. 4th ed. 2007;8:282-284.
2. Chang CH. Advanced Damon Course No. 1: Crowding: Ext vs. Non-ext., Beethoven Podcast Encyclopedia in Orthodontics 2011, Newton's A Ltd, Taiwan.
3. Bagden A. A Conversation. The Damon System: Questions And Answers. Clinical Impressions 2005;14(1);4-13.
4. Hsu YL. Approaching Efficient Finishing: Hard and soft tissue contouring. Part II: hard tissue contouring. News & Trends in Orthodontics 2008;11:17-19.
5. Chang CH. Basic Damon Course No. 5: Finish Bending, Beethoven Podcast Encyclopedia in Orthodontics 2012, Newton's A Ltd, Taiwan.
6. Kozlowski J. Honing Damon System. Mechanics for the Ultimate in Efficiency and Excellence. Clinical Impressions 2008;16(1);23-28.
7. Chang CH. Advanced Damon Course No. 4,5: DI&CRE Workshop (1)(2). Beethoven Podcast Encyclopedia in Orthodontics 2011, Newton's A Ltd, Taiwan.
8. Knierim K, Roberts WE, Hartsfield Jr JK. Assessing treatment outcomes for a graduate orthodontics program: follow-up study for classes of 2001-2003. Am J Orthod Dentofac Orthop 2006;130(5):648-655.

Discrepancy Index Worksheet

TOTAL D.I. SCORE 14

OVERJET

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

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

Total = 3

OVERBITE

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

Total = 2

ANTERIOR OPEN BITE

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

Total = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

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

Total = 7

OCCLUSION

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

Total = 2

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

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

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

SN-MP

≥ 38° = 2 pts.

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

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 0

OTHER (See Instructions)

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

Identify:

Total = 0

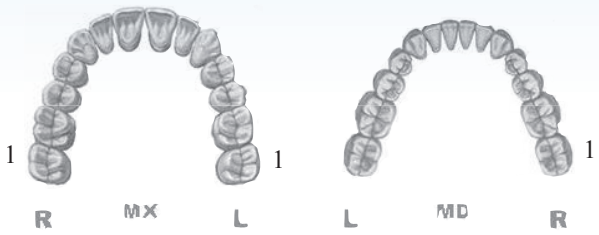
Cast-Radiograph Evaluation

Case # 1 **Patient**

Total Score: 21

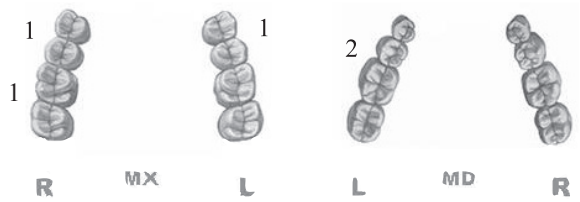
Alignment/Rotations

3



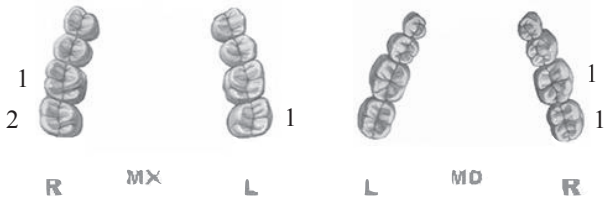
Marginal Ridges

5



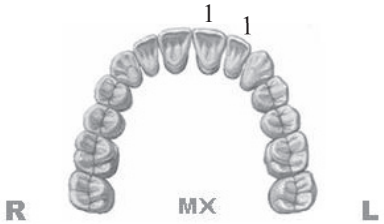
Buccolingual Inclination

6



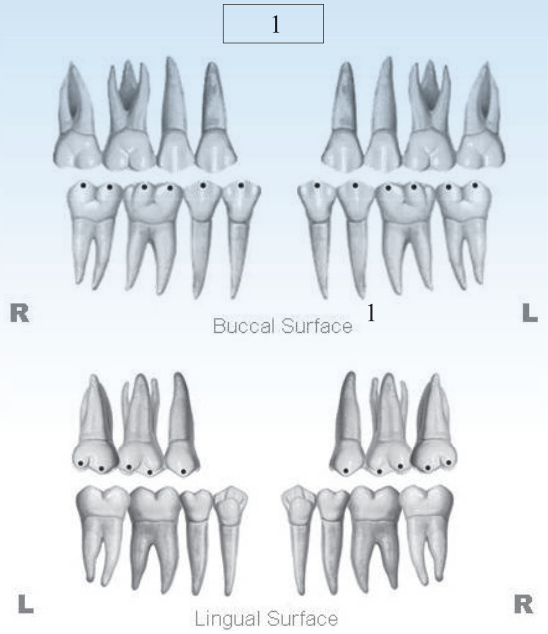
Overjet

2



Occlusal Contacts

1

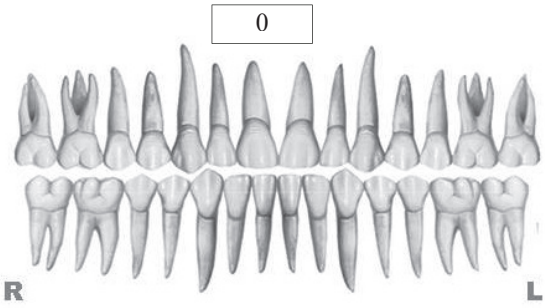


Occlusal Relationships

0

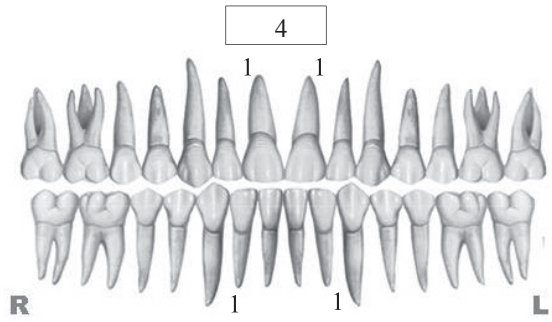
Interproximal Contacts

0



Root Angulation

4



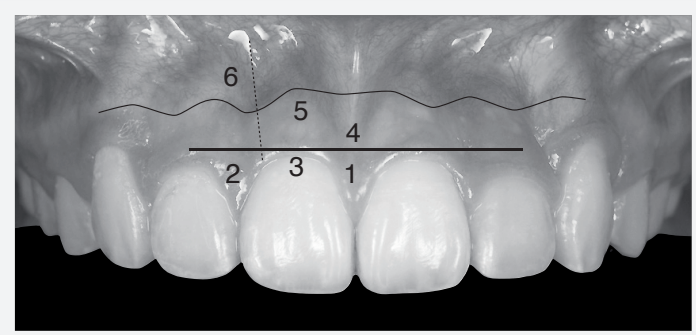
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 4

1. Pink Esthetic Score

Total = 2

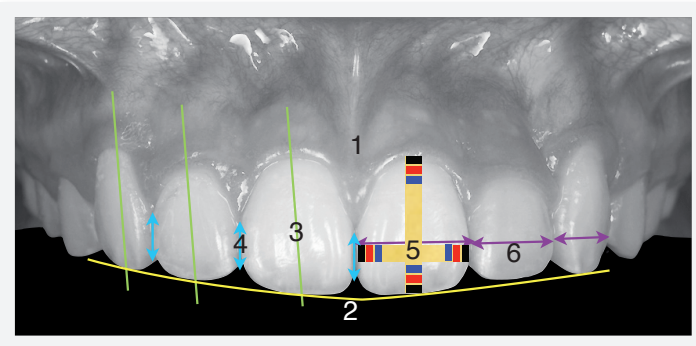


1. Mesial Papilla	0	1	2
2. Distal Papilla	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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-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