IZC Bone Screw Anchorage for Conservative Treatment of Bimaxillary Crowding in an Asymmetric Class II/I Subdivision 1 Malocclusion

Abstract

***Introduction**: A 23-year-old male presented for orthodontic consultation to evaluate chief complaints of severe crowding and protrusive lips.*

***Diagnosis**: Clinical and radiographic examination revealed a convex facial profile (G-Sn-Pg' 19°), protrusive lips, hypermentalis activity, coincident midlines, mandible deviation to the right, asymmetric Class II/I subdivision-right malocclusion, narrow arches, 7-8mm of crowding in each arch, and a relatively high mandibular plane angle (SN-MP 37°). The Discrepancy Index was 20 points.*

***Treatment**: All permanent teeth were erupted except for horizontally impacted lower third molars. Following extraction of all four third molars, a passive fixed self-ligating appliance was installed. Infrazygomatic crest (IZC) bone screws were inserted buccal to the upper molars to provide posterior skeletal anchorage to retract both arches. Expansion of the constricted maxillary arch was initiated with light buccal force, that was delivered with a circular-formed 0.016-in copper nickel titanium (CuNiTi) archwire. The bite was opened with an anterior bite turbo, and all four buccal segments were differentially retracted, to correct intermaxillary crowding and asymmetric Class II interdigitation, with IZC anchorage and Class III elastics. Third order correction and finishing were accomplished with rectangular archwires and a root torquing auxiliary. Active treatment time was 26 months.*

***Outcomes**: Excellent dental and periodontal results were achieved: Cast-Radiograph Evaluation of 21 and a Pink & White Esthetic Score of 5. Lip protrusion and incompetent lips were corrected to the patient's satisfaction, but there was a 2mm retraction and 2° clockwise rotation of the mandible, that increased both the lower facial height (LFH) and facial convexity (FC).*

***Conclusions**: Retrospective analysis indicated that the mandibular retrusion and clockwise rotation were related to extrusion of the lower molars, and an undiagnosed sagittal slide in occlusion (C_R to C_O discrepancy), as evidenced by wear facets on the initial casts. (Int J Orthod Implantol 2017;48:4-22)*

Key words:
Asymmetric Class II/I, Subdivision 1 malocclusion, passive self-ligating appliance, extra-alveolar (E-A) bone screw anchorage, infrazygomatic (IZC) miniscrew anchorage, anterior bite turbo, sagittal slide in occlusion, centric relation and centric occlusion discrepancy, wear facets

History and Etiology

A 23-year-old male presented for orthodontic evaluation with two chief complaints: severe crowding and protrusive lips. Clinical and radiographic evaluations showed a modest intermaxillary discrepancy (*ANB 4°*) that was due to a slightly protrusive maxilla (*SNA 83°*) and slightly retrusive mandible (*SNA 79°*). The convex facial profile (*G-Sn-Pg' 19°*) was associated with increased lower facial height (*60%*), excessive lip protrusion (*2mm/3.5mm to the E-Line*), and hypermentalis strain when the lips were closed (*Fig. 1*). This morphologic pattern is commonly referred to as an increase in lower facial height (*LFH*) and/or an excessive

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vertical dimension of occlusion (*VDO*). An intraoral examination and study casts revealed canine and molar relationships that were Class II on the right side and Class I on the left (*Class II/I subdivision-right malocclusion*). Excessive overjet (*6mm*) was associated with a deep overbite (*4mm*), and there was 7-8mm of crowding in each arch (*Fig. 2*). The dental and facial midlines were coincident, but the chin was deviated to the right (*Fig. 1*).

Fig. 1: Pre-treatment facial and intraoral photographs

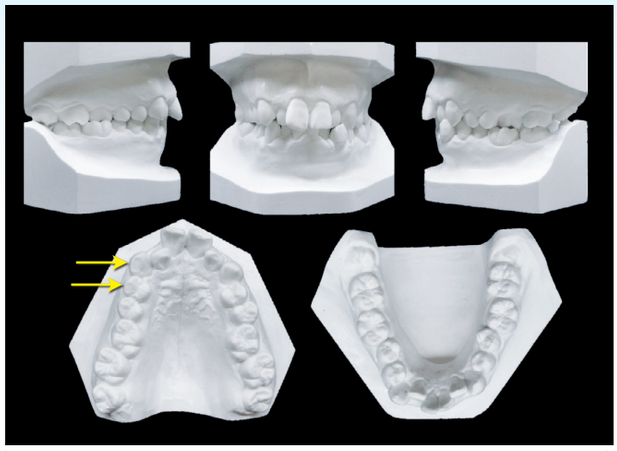


Fig. 2: Pre-treatment dental models (casts) are marked with yellow arrows to show wear facets.

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	83°	83°	0°
SNB° (80°)	79°	77°	2°
ANB° (2°)	4°	6°	2°
SN-MP° (32°)	34°	36°	2°
FMA° (25°)	27°	29°	2°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	6 mm	3 mm	3 mm
U1 To SN° (104°)	106°	99°	7°
L1 To NB mm (4 mm)	10.5 mm	10.5 mm	0 mm
L1 To MP° (90°)	93°	97°	4°
FACIAL ANALYSIS			
E-LINE UL (-1 mm)	2 mm	1 mm	1 mm
E-LINE LL (0 mm)	3.5 mm	3.5 mm	0 mm
%FH: Na-ANS-Gn (53%)	60%	62%	2%
Convexity: G-Sn-Pg' (13°)	19°	21°	2°

Table 1: Cephalometric summary

The pre-treatment cephalometric radiograph confirmed a retrusive facial pattern (*G-Sn-Pg' 19°, SNA 83°, SNB 79°, ANB 4°*), with a high mandibular plane angle (*SN-MP 34°*) (*Fig. 3 & Table 1*). The panoramic radiograph (*Fig. 4*) showed bilateral horizontal impaction of the mandibular 3rd molars (*LR8 and LL8*). Three dimensional (*3D*) imaging with cone-beam computed tomography (*CBCT*) revealed the proximity of the lower third molars to the inferior mandibular canal (*Fig. 5*). Skeletal, dental and facial analyses are detailed in the diagnosis section.

The treatment of this asymmetric Class II/I Subdivision malocclusion with an increased VDO was a challenge that was best managed with extra-alveolar (*E-A*) bone screw (*BS*) anchorage.[1-3]

Fig. 3: Pre-treatment lateral cephalometric radiograph

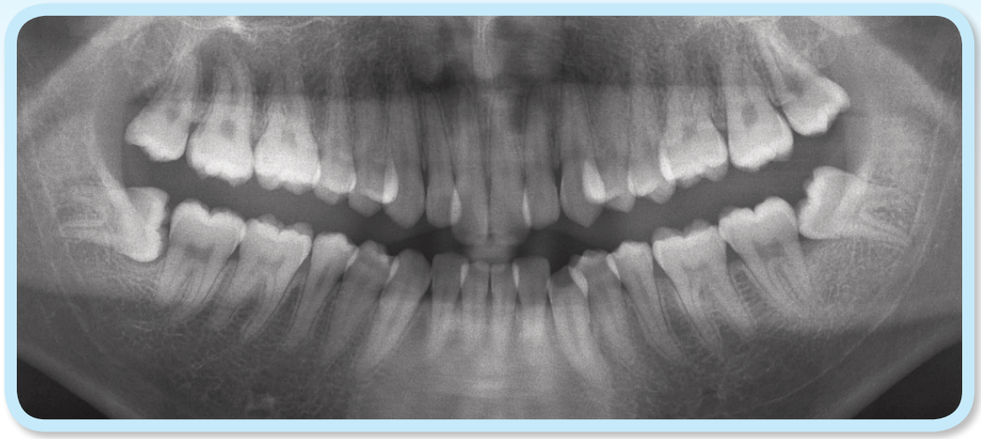


Fig. 4: Pre-treatment panoramic radiograph

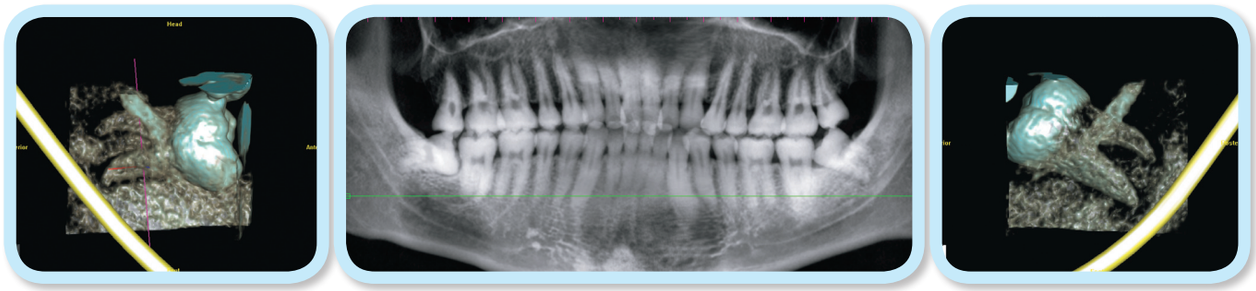


Fig. 5:
CBCT 3D imaging was used to evaluate the relationship between the lower third molar roots and the inferior alveolar canal bilaterally.

The infrazygomatic crest (*IZC*) was an ideal site for temporary anchorage devices (*TADs*) to retract both arches.[1,2]

Diagnosis

Skeletal:

- Lower face is retrusive: *SNA 83°, SNB 79°, and ANB 4°*
- Mandibular plane angle is increased: *SN-MP 34°, FMA 27°*
- Facial asymmetry: *In contrast to coincident facial and dental midlines, the chin point is deviated to the right.*

Dental:

- Buccal (*canine and molar*) relationships: *Class II on the left and Class I on the right.*
- Overjet: *6mm*
- Overbite: *4mm (40%)*
- Crowding: *7mm in the upper arch and 8mm in the lower arch*
- Third molars: *LL8 and LR8 were horizontally impacted*

- Midlines: *Dental and facial midlines were coincident*
- Arch-forms: *Constricted in both arches*

Facial:

- Profile: *Increased convexity (G-Sn-Pg' 19°)*
- Nasolabial Angle: *Increased*
- Anterior-Posterior: *Retrognathic mandible, maxilla was within normal limits (WNL)*
- Protrusive Lips: *2mm/3mm to the E-Line*
- Hypermentalis Strain: *With lips closed*

The American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) was 20 points as shown in the subsequent worksheet 1.[4]

Treatment Objectives

1. Level and align both arches
2. Correct overjet and overbite
3. Retract the lips and control the VDO to relieve mentalis strain
4. Skeletal Relationships: *Maintain the maxilla and mandible in all three planes*
5. Maxillary and mandibular dentition:
   a. Nonextraction alignment of both arches
   b. Optimize the intermaxillary occlusion
   c. Relieve bimaxillary crowding
   d. Obtain an ideal overjet and overbite
   e. Obtain Class I canine and molar relationships
6. Facial esthetics: *Retract the protrusive lips and establish lip competence*

Treatment Alternatives

It is well established that symmetric or asymmetric extraction of premolars is the traditional approach for correction of a severely crowded dentition in an adult. However, the present patient preferred a conservative (*non-extraction*) approach, but understood that arch expansion and TAD anchorage were necessary. Since buccal segment retraction was required in each quadrant, extraction of all four third molars was indicated.

Comprehensive treatment was planned as specified below. Install a full fixed, self-ligating orthodontic appliance to align the dentition, level the arches, and reduce the overjet. Place 2x8mm stainless steel (*SS*) IZC bone screws bilaterally to provide posterior maxillary anchorage for intermaxillary retraction. Use an anterior bite turbo to open the bite for retraction of the maxillary dentition with IZC bone screw anchorage to correct crowding, lip protrusion and interdigitation discrepancies. Class III elastics are indicated for retraction of the lower dentition to correct crowding and the axial inclination of the incisors. Following alignment, detail the occlusion with finishing bends and intermaxillary elastics. Remove fixed appliances and deliver clear overlay retainers for both arches.

Treatment Progress

Following CBCT confirmation that the lower 3rd

Fig. 6:
Upper arch retraction was initiated by applying a chain of elastics from each maxillary TAD to the corresponding upper first premolar. Class III elastics were used, from the lower canines to upper 1st molars bilaterally, to resolve the anterior crowding.

molars were not impinging on the inferior alveolar nerve (*Fig. 5*), all four 3rd molars were extracted prior to commencing orthodontic treatment. A full fixed 0.022-in slot Damon Q® bracket system (*Ormco, Glendora, CA*) was used with archwires and auxiliaries supplied by the same manufacturer. All brackets were standard torque except for the lower anteriors, where low torque brackets were used. Initial archwires were 0.013-in CuNiTi in both arches. A 2x8mm SS IZC miniscrew was installed buccal to the upper first and second molars, bilaterally (*Figs. 6 and 7*). Upper arch retraction was initiated at the start of treatment by applying a chain of elastics from each maxillary TAD to the corresponding upper first premolar (*U4*). Class III elastics (*Quail 3/16-in 2-oz*) applied compressive force from the lower canines to upper 1st molars bilaterally, to resolve the lower anterior crowding (*Fig. 6*). Two months later, the Class III elastics were changed to Fox (*1/4-in 3.5-oz*).

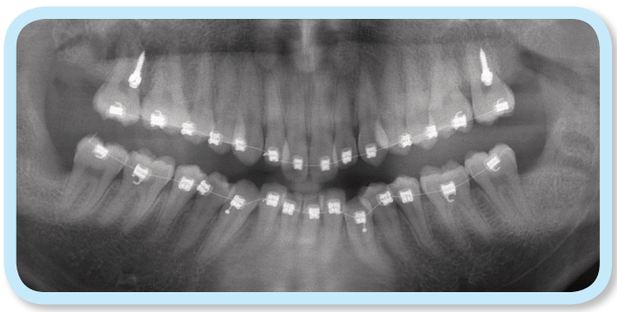


Fig. 7:
2x8mm SS bone screws were installed the IZC bilaterally.

At four months (*4M*) into treatment, alignment of the upper arch was improving, but the maxilla was still quite narrow (*Fig. 8*). The mandibular arch was well aligned (*Fig. 9*) as the lower buccal segments were retracted. A 0.016-in CuNiTi archwire was circled on a small mandrel to distort the arch-form in the form of a circle (*Fig. 8*), and then it was engaged in the maxillary brackets to expand the narrow maxillary arch. Two buttons were bonded on the palatal side of the upper right 2nd premolar (*UR5*) and 1st molar (*UR6*) to attach a criss-cross elastic (*Fox 1/4-in 3.5-oz*) to the lower right 2nd premolar (*LR5*) and 1st molar (*LR6*) (*Fig. 8*). On the left buccal segments, Fox Class III elastics were continued. One month later (*5M*), the Class III elastics were increased to Kangaroo (*3/16-in 4.5-oz*).

Fig. 8: In the 4th month, a circular form 0.016-in CuNiTi archwire was placed to expand the narrow maxillary arch.

Fig. 9:
Four months (4M) into treatment, the crowded lower anteriors were aligned, and Class III elastics were discontinued as documented in the Archwire Sequence Chart (Table 3).

In the 6th month of the treatment (*6M*), the upper archwire was changed to a 0.018x0.025-in CuNiTi. Class III elastics were used on the left side only and changed to Fox. The upper arch retraction mechanics were still engaged from the maxillary TADs to the upper first premolars using power chains (*Fig. 10*).

In the 8th month, the archwires were changed to a 0.016x0.022-in SS in the upper and 0.017x0.025-in titanium-molybdenum alloy (*TMA*) in the lower. Bracket repositioning was performed repeatedly as needed to correct axial inclinations in the buccal segments. Power chains were attached from the upper right central incisor to the first molar bilaterally to close space as the buccal segments were retracted.

In the 15th month of treatment (*15M*), both archwires were replaced with 0.014x0.025-in NiTi archwires. An anterior bite-turbo (*BT*) composed of glass Ionomer cement[5] was bonded on the lingual surfaces of the upper central incisors. The BT(*s*) opened the bite, thereby providing an intrusive force on the upper and lower incisors. They also created a posterior open bite to facilitate full arch retraction. As the arches were leveled and aligned, space was created distal to the upper left lateral incisor (*UL2*) by retracting the left buccal segment (*Fig. 11*).

Fig. 10:
Six months (6M) into treatment, crowding in the maxillary arch was corrected by arch expansion and retraction of the buccal segments with IZC anchorage.

Fig. 11:
In the 15th month of treatment (15M), both arches were fitted with 0.014x0.025-in NiTi archwires. An occlusal bite-turbo (BT) composed of glass ionomer cement was bonded on the lingual surfaces of the upper central incisors to correct anterior deepbite and facilitate maxillary arch retraction.

In the 20th month (*20M*), the IZC bone screw on the left side became loose and was removed because it was no longer needed (*Fig. 12*). Three months later (*23M*), the upper archwire was changed to 0.016x0.025-in SS for expansion of the posterior segments. Upper arch retraction mechanics were continued on the right side with a power chain from the TAD to the upper right first premolar (*Fig. 13*).

Cross elastics were applied from the buttons bonded on the lingual surfaces of the LR4, LR6 and LR7 to the buccal surfaces of the UR4, UR6 and UR7 (*Fig. 14*).

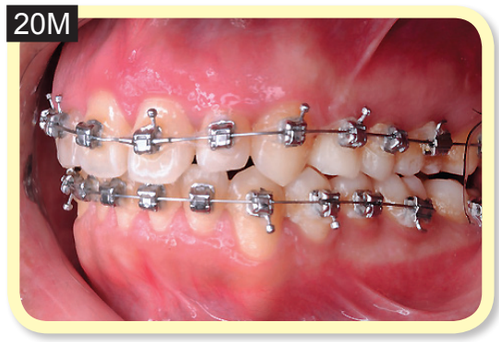
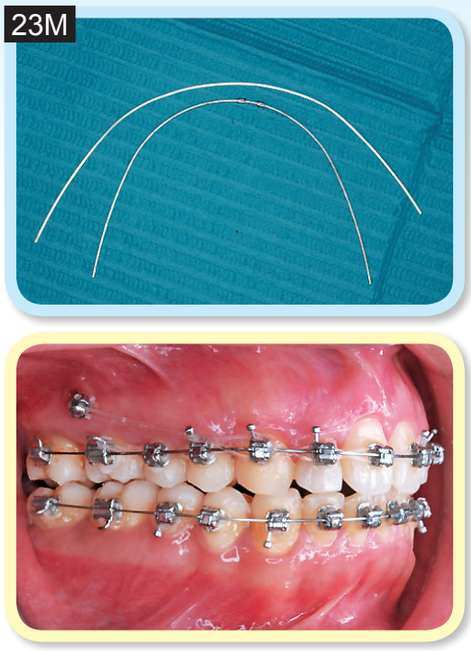


Fig. 12:
In the 20th month (20M), the left IZC miniscrew had been removed.



The unilateral cross elastics on the right side helped correct maxillary arch asymmetry as the buccal segment was retracted. One month later *(25M)* a torquing spring was placed on the upper right lateral incisor to move the UR2 root labially, as the maxillary arch was finished (*Fig. 15*). After 26 months of treatment, all fixed appliances were removed.

■ *Fig. 13:*
In the 23rd month, the upper archwire was changed to 0.016x0.025-in SS to expand of the posterior segments (above). Upper arch retraction of the right maxillary buccal segment was continued.

■ *Fig. 15:*
A torquing spring auxiliary was placed on the upper right lateral incisor to move its root labially.

■ *Fig. 14:*
At twenty-four months (24M) into treatment, frontal and lateral intraoral photographs document progress (upper). Cross elastics were applied from the buttons bonded on the lingual side of the lower teeth (lower right) to the buccal surface of their antagonists (bottom left).

Results achieved

Maxilla (*all three planes*):

- A - P: *Maintained*
- Vertical: *Maintained*
- Transverse: *Expanded with correction of asymmetry*

Mandible (*all three planes*):

- A - P: *Retracted (posterior rotation)*
- Vertical: *Increased (posterior rotation)*
- Transverse: *Maintained*

Maxillary Dentition

- A - P: *Retracted*
- Vertical: *Incisors intruded*
- Inter-molar / Inter-canine Width: *Increased with correction of asymmetry*

Mandibular Dentition

- A - P: *Maintained*
- Vertical: *Increased (molar extrusion)*
- Inter-molar / Inter-canine Width: *Maintained / Increased*

Facial Esthetics:

- Posterior Rotation of the Mandible: *Increased FC (21°) and excessive LFH (62%)*
- Lips: *Retracted to improve facial balance*
- Mentalis Strain: *Relieved by retracting the lips*
- Lip protrusion: *Improved*
- Facial Profile: *More convex (Figs. 16-20)*

Retention

Hawley retainers were delivered for both arches to be worn full time for the first 6 months and nights only thereafter. Plaque control and retainer maintenance instructions were provided.

Final evaluation of treatment

There was a 2% increase in both LFH and FC that was associated with extrusion of the lower molars (*Fig. 20*). The relatively longer, more retrusive facial pattern appeared to be a sequelae of the anterior BT(*s*) used to correct the deepbite and facilitate arch retraction (*Fig. 11*). Despite the increase in FC, there was an overall improvement in lip protrusion, lip competence, dental alignment and functional occlusion (*Figs. 16-19*). The final alignment was assessed at 21 points with ABO Cast-Radiograph Evaluation (*CRE*),[6] as documented in the supplementary worksheet at the end of this report. Major residual discrepancies were noted in three categories: marginal ridges (*6 points*), occlusal contacts (*6 points*) and occlusal relationships on the right side (*5 points*). Overbite was reduced from 4 to 1mm, but the Class II discrepancy was not completely corrected on the right side. In addition, the mandibular second molars were tipped distally because of an inadequate root-distal moment in the archwire. These axial inclination problems (*Fig. 18*) resulted in marginal ridges discrepancies in the posterior segments (*Figs. 16 and 17*). The Pink and White dental esthetic score was 5 points, as subsequently documented in worksheet, which is consistent with the outcomes recommended by Sarver and Yanosky.[7]

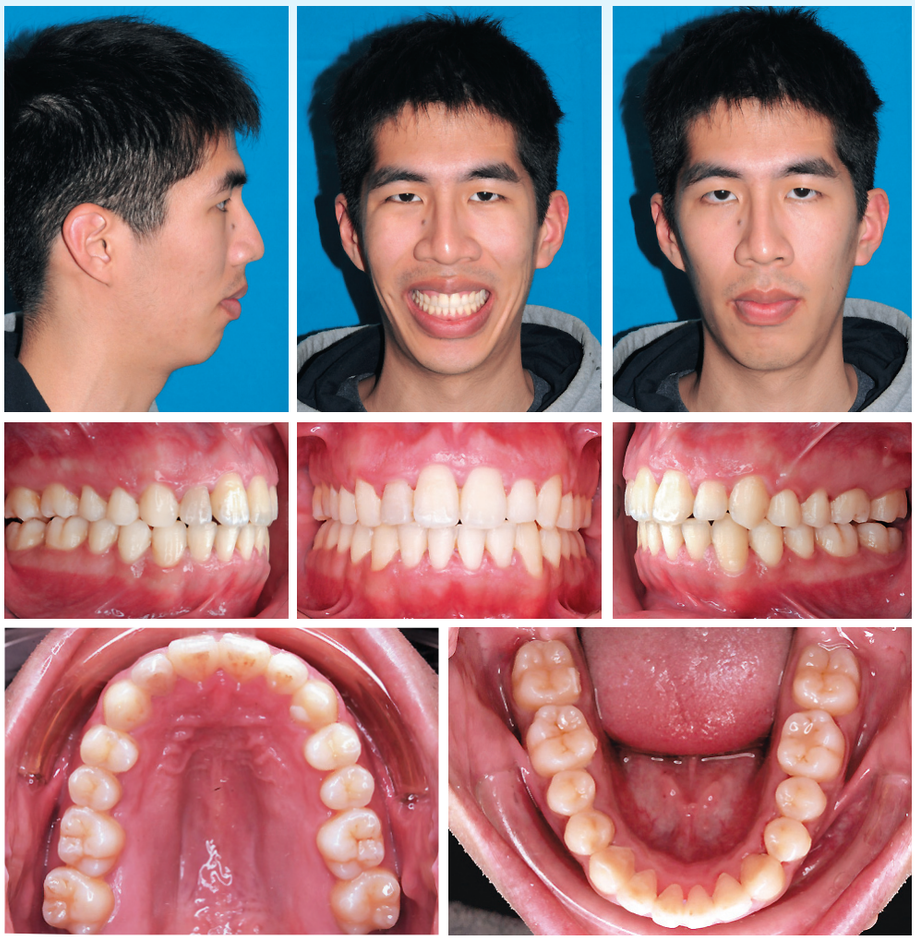


Fig. 16: Post-treatment facial and intraoral photographs

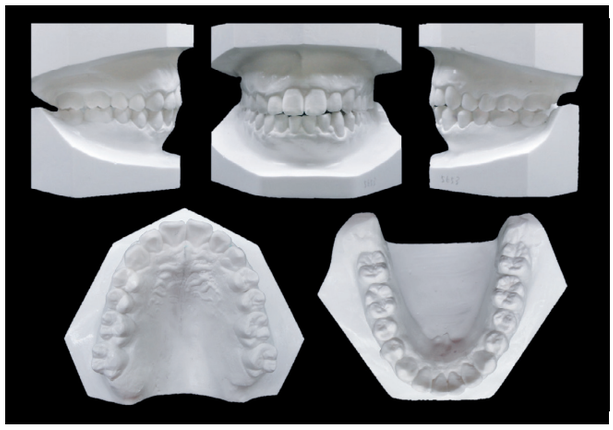


Fig. 17: Post-treatment dental models (casts)

Fig. 18: Post-treatment panoramic radiograph

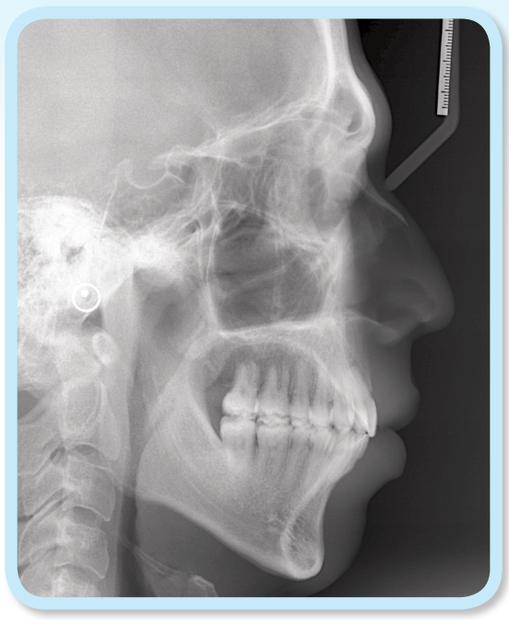


Fig. 19: Post-treatment lateral cephalometric radiograph

Discussion

Ast et al.[8] examined 1413 high school students aged 15-18 years from upstate New York and found that 23.8% had Class II malocclusions, compared to 69.9% with Class I malocclusions, which was a ratio of ~1:3. The underlying etiology of Class II malocclusions was originally thought to be genetic, based primarily on racial and familial characteristics, but more recent studies suggest that many malocclusions previously thought to be genetic are actually acquired.[9-11] Environment can play an important role in the development of certain types of malocclusions. For example, the early loss of the maxillary second deciduous molars or palatial ectopic eruption of second premolars may result in mesial migration of

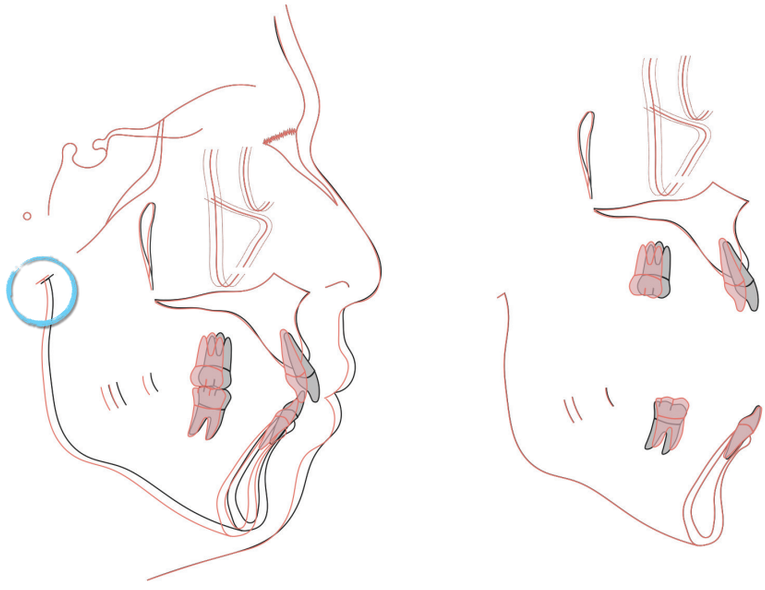
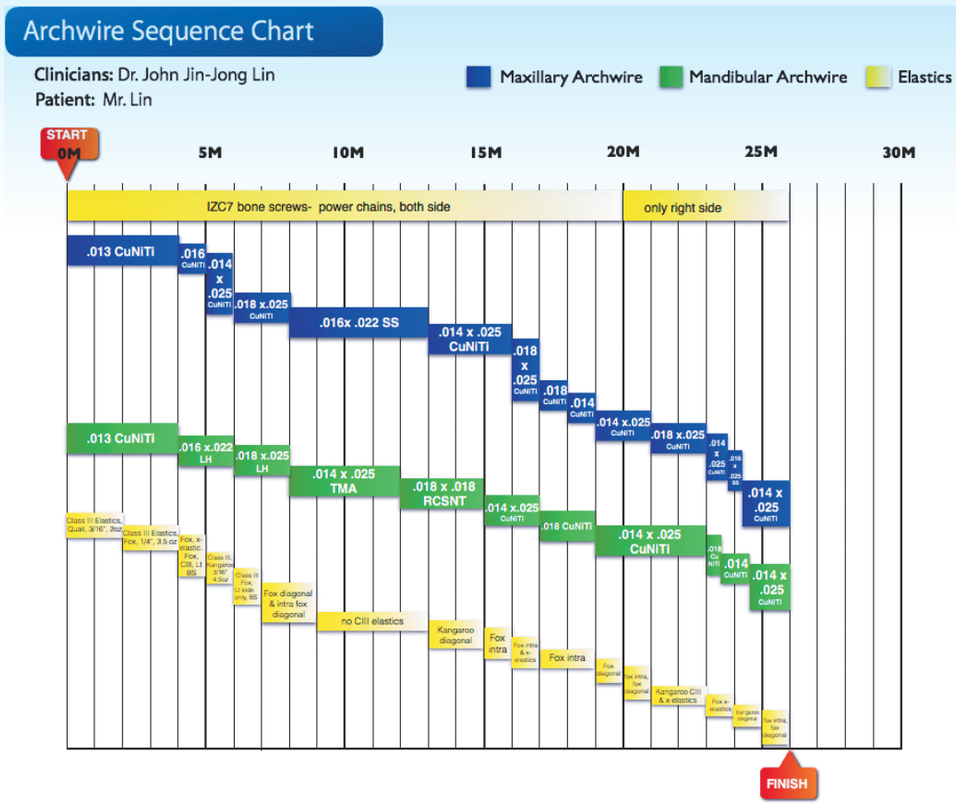


Fig. 20:
Superimposed cephalometric tracings show dentofacial changes over 26 months of treatment (red) compared to the pre-treatment position (black). The anterior cranial base superimposition (left) documents the retraction of the protrusive lips and opening of the VDO as the mandible rotated clockwise. The LFH increased and the mandible assumed a more posterior posture (blue circle). The upper right superimposition on the maxilla shows the retraction of the dentition relative to the apical base of bone. The lower left superimposition on the mandible reveals the extrusion of the mandibular molars. See text for details.



the permanent molars.[12] Furthermore, a persistent finger sucking habit increased overjet, the lower lip may become trapped behind the maxillary incisors, causing abnormal contraction of the mentalis muscle and other perioral muscles leading to uprighting of lower incisors and labial tipping of maxillary incisors.[13] Another proposed etiology for functional types of malocclusion is mouth breathing, which may precipitate a low tongue posture and openbite as a result of nasal or adenoid obstruction.[14,15]

Class II division 2 malocclusion may be associated with mandibular retrusion, maxillary protrusion, increased VDO, posterior positioning of the TMJ fossa, and/or maxillary constriction.[16] For Class II division 1 malocclusion, maxillary incisors tend to be more protrusive when the lower lip is postured in the overjet.[15,17]

Facial esthetics is a critical consideration when considering extractions to alleviate crowding. Four permanent premolars, one in each quadrant, are commonly extracted to treat Class II malocclusion in adults.[16] In general, the skeletal features of a Class II malocclusion are not the primary determinant for extractions. Crowding and differential anchorage requirements are usually the deciding factor(s).

In recent decades, TADs have been increasingly popular for managing difficult malocclusions in adults.[18,19] However, the interradicular position of the miniscrews, a high failure rate, and their

tendency to move when loaded has limited their application for conservative treatment of skeletal malocclusions, particularly when there is crowding.[1-3] Skeletal orthodontic anchorage systems (*TADs*) can provide adequate anchorage for management of severe malocclusions without extensive patient compliance.[1-3]

The present patient felt the convex facial profile was acceptable, but excessive lip protrusion was undesirable (*Fig. 1*). Correcting an Angle Class II/I subdivision malocclusion without extractions requires retraction of a maxillary molar(*s*). The IZC is an ideal maxillary site for the placement of orthodontic bone screws to retract both arches.[1-2]

IZC miniscrews, positioned buccal to the maxillary molars, were an ideal solution for retracting the upper arch and reducing bimaxillary protrusion.[1,2] Failure to completely correct the Class II relationship on the right side was related to a lack of overjet after the axial inclinations of the incisors was corrected. More retraction with IZC anchorage on the right side would have resulted in a midline deviation and end-to-end incisal occlusion. Interproximal reduction (*IPR*) of the enamel on the lower incisors and retraction with a chain of elastics to close IPR space was indicated to produce overjet for Class II correction of the right buccal segment. Once overjet is created, IZC anchorage on the right side was ideal for completing the Class II correction of the right buccal segments. However, retraction of a maxillary segment to correct Class II occlusion requires adequate overjet.

The lower third molars were extracted prior to retraction of the lower molars. Cephalometric superimposition on the mandible (*Fig. 20*) shows extrusion and distal tipping of the lower molars, but no net retraction relative to the apical base of bone. This is an illusion in a 2D cephalometric view (*Fig. 19*). The lower arch was expanded, so the molars were distally tipped as shown in the post-treatment panoramic radiograph (*Fig. 18*). There was no A-P change in the 2D cephalometric views because the arch was expanded, so its A-P length in the sagittal plane was reduced (*Fig. 20*).

Overall, the non-extraction approach using IZC miniscrew anchorage produced good dental alignment and reduced lip protrusion, but there was an increase in the VDO as reflected by ~2° increase in the following: facial convexity, SNB and mandibular plane angle (*FMA*). These undesirable sequelae are consistent with two changes noted in the cephalometric tracings: 1. lower molars are extruded ~2mm in the mandibular superimposition (*Fig. 20 lower right*), and 2. the mandible moved distally ~2mm as it rotated posteriorly ~2° in the anterior cranial base superimposition (*Fig. 20 left*). The molar extrusion problem can be explained by the use of anterior BTs (*Fig. 11*).[5] The posterior displacement of the mandible during treatment suggests a discrepancy between centric relation (C_R) and centric occlusion (C_O). There was no documentation of a $C_R \rightarrow C_O$ shift in the initial examination, but the pretreatment casts (*Fig. 2*) suggest it may have been a long-term problem. Wear facets are noted on the distal inclines of the UR3 cusp and the buccal cusp of UR4 (*Fig. 6*). Apparently, the patient habitually positioned the mandible in a more anterior position, which may have been related to parafunction, and

the path of the anterior excursion of the mandible is evidenced by two wear facets (*yellow arrows in Fig. 6*).

Intermaxillary elastics commonly extrude molars and increase the VDO because of the vertical component of force. This problem can be avoided by using both maxillary and mandibular E-A bone screws for intra-alveolar force in each arch rather than relying on intermaxillary anchorage.[1-3,10-12] For the present patient, there is no documentary evidence that the Class III elastics (*Fig. 10*) contributed to the increase in the VDO. No extrusion of the maxillary molars were noted relative to the apical base of bone in the maxillary superimposition (*Fig. 20 upper right*). Control of the expected upper molar extrusion was apparently controlled by the vertical component of the IZC retracting force (*Fig. 10*).

Conclusions

This challenging malocclusion (*DI=20*), was treated conservatively (*without extractions*) in 26 months to an excellent dental alignment (*CRE=21*) with relatively simple mechanics. IZC bone screw anchorage combined with Class III elastics were effective mechanics for intermaxillary retraction to resolve crowding in both arches and to correct the asymmetric Class II molar relationship. However, mandibular molar extrusion and an apparent $C_O \rightarrow C_R$ discrepancy contributed to increased facial convexity, that was associated with a more posterior position and clockwise rotation of the mandible.

Acknowledgment

Thanks to Mr. Paul Head for proofreading this article.

References

1. Lin JJ. C reative Orthodontics Blending the Damon system & TADs to manage difficult malocclusions. 2nd ed. Taipei: Yong Chieh Co; 2010.
2. Huang TK, Chang CH, Roberts WE. Bimaxillary protrusion treated with miniscrews. Int J Orthod Implantol 2014;34:78-89.
3. Lin JJ. Treatment of severe class III with buccal shelf mini-screws. News & Trends in Orthodontics 2010 Apr;18:4-15.
4. Cangialosi TJ, Riolo ML, Owens SE, Jr, Dykhouse VJ, Moffitt AH, Grubb JE, Greco PM, English JD, James RD. The ABO discrepancy index: a measure of case complexity. Am J Orthod Dentofacial Orthop 2004;125(3):270-8.
5. Mayes JH. Bite Turbos. New levels of bite-opening acceleration. Clinical Impression 1997;6:15-17.
6. Casko JS, Vaden JL, Kokich VG, Damone J, James RD, Cangialosi TJ, Riolo ML, Owens SE, Jr, Bills ED. Objective grading system for dental casts and panoramic radiographs. American Board of Orthodontics. Am J Orthod Dentofacial Orthop 1998;114(5):589-99.
7. Sarver DM, Yanosky M. Principles of cosmetic dentistry in orthodontics: part 2. Soft tissue laser technology and cosmetic gingival contouring. Am J Orthod Dentofacial Orthop 2005;127:85-90.
8. Ast DB, Carlos JP, Cons DC. Prevalence and characteristics of malocclusion among senior high school students in up-state New York. Am J Orthod 1965;51:437-445.
9. Roberts WE, Hartsfield JK Jr. Multidisciplinary management of congenital and acquired compensated malocclusions: diagnosis, etiology and treatment planning. J Indiana Dent Assoc 1997;76(2):42-53.
10. Chang MJ, Chang CH, Roberts. Probable airway etiology for a severe Class III openbite malocclusion: conservative treatment with extra-alveolar bone screws and intermaxillary elastics. Int J Orthod Implantol 2017;45:4-20.
11. Lee A, Chang CH, Roberts WE. MIH-related loss of mandibular first molars resulted in an acquired Class II skeletal malocclusion: conservatively treated with space closure on one side and implant-supported prosthesis on the other. Int J Orthod Implantol 2017;47:26-48.
12. Tseng LYL, Chang CH, Roberts WE. Diagnosis and conservative treatment of skeletal Class III malocclusion with anterior crossbite and asymmetric maxillary crowding. Am J Orthod Dentofac Orthop 2016;149:555-66.
13. Lear CSC, Flanagan JB, Moorrees CFA. The frequency of deglutination in man. Arch Oral Biol 1965;10:83-99.

14. Neto ACB, Saga AY, Pacheco AAR, Tanaka O. Therapeutic approach to Class II, Division 1 malocclusion with maxillary functional orthopedics. Dental Press J Orthod 2015;20(4):99-125.
15. Rijpstra C, Lisson JA. Etiology of anterior open bite: a review. J Orofac Orthop 2016 Jul;77(4):281-6.
16. Cleall JF, Begole EA. Diagnosis and treatment of class II division 2 malocclusion. Angle Orthod 1982;52:38-60.
17. Weinstein S, Haack DC, Morris LY, Snyder BB, Attaway HE. On the equilibrium theory of tooth position. Angle Orthod 1963;33(1):1-26.
18. Park HS, Lee SK, Kwon OW. Group distal movement of teeth using microscrew implant anchorage. Angle Orthod 2005;75:602-9.
19. Park HS, Kwon TG, Sung JH. Nonextraction treatment with microscrew implants. Angle Orthod 2004;74:539-49.

Discrepancy Index Worksheet

TOTAL D.I. SCORE 20

OVERJET

0 mm. (edge-to-edge)	=	
1 – 3 mm.	=	0 pts.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	3 pts. 6mm
7.1 – 9 mm.	=	4 pts.
> 9 mm.	=	5 pts.

Negative OJ (x-bite) 1 pt. per mm. per tooth = 2 pt

Total = 5

OVERBITE

0 – 3 mm.	=	0 pts.
3.1 – 5 mm.	=	2 pts. 4mm
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

8mm (lower)

OCCLUSION

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

Total = 4

Full Class II (right)

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 2

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

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

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

SN-MP

≥ 38° = 2 pts.

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

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 0

OTHER (See Instructions)

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

Identify:

Total = 0

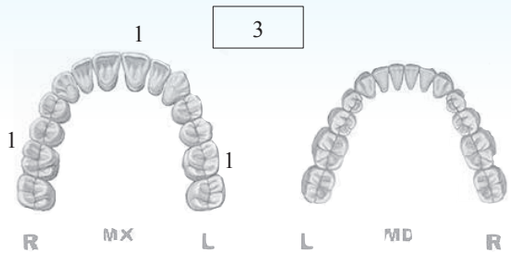
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 21

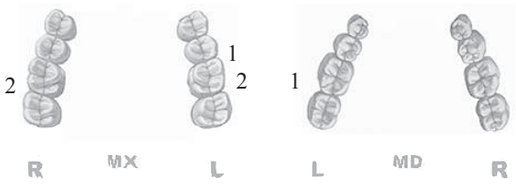
Alignment/Rotations

3



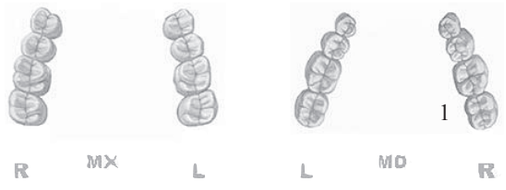
Marginal Ridges

6



Buccolingual Inclination

1

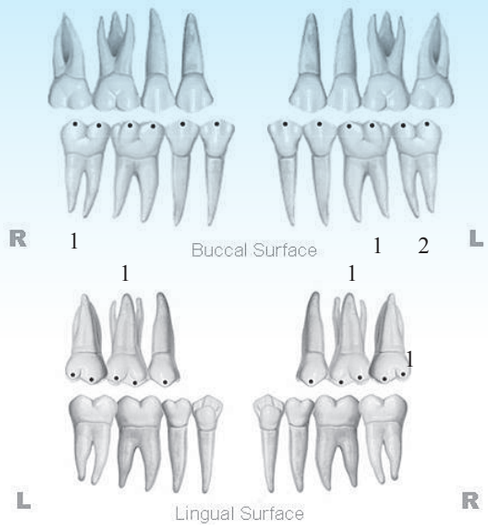


Overjet

0

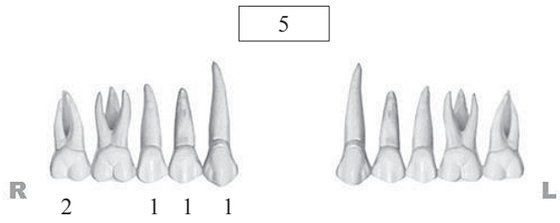
Occlusal Contacts

6



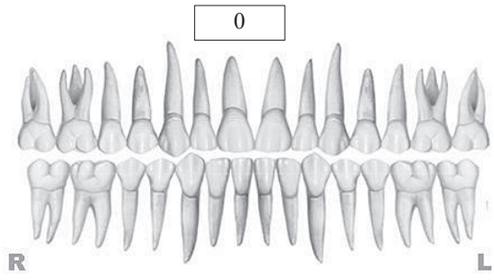
Occlusal Relationships

5



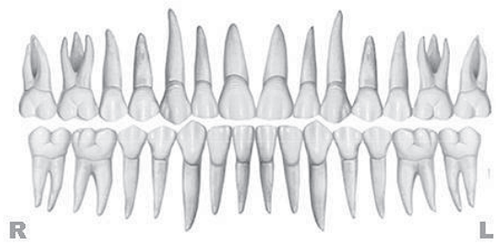
Interproximal Contacts

0



Root Angulation

0



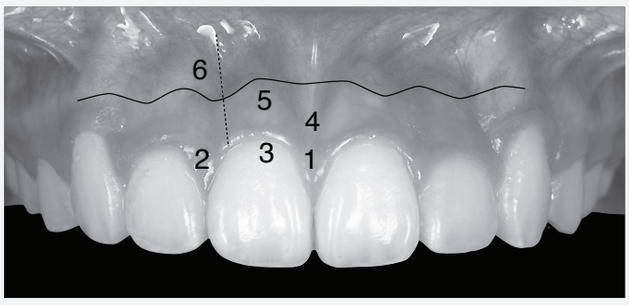
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 5

1. Pink Esthetic Score

Total = 2

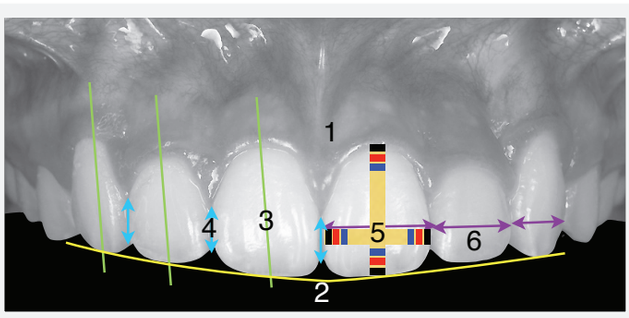


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

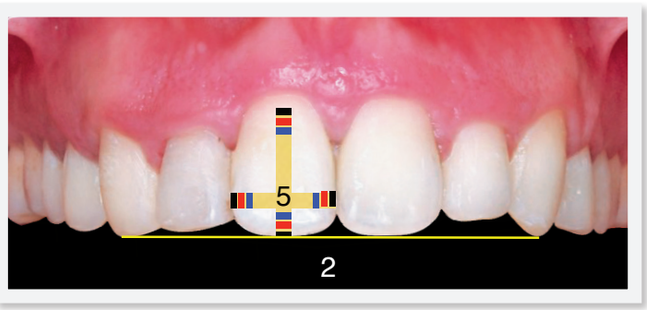
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	(0)	1	2
4. Level of Gingival Margin	0	1	(2)
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

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	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