Periodontally-Compromised Class II Malocclusion with Early Loss of Both L6s and the UL3: Class III Elastics for L6 Space Closure and Retraction of the Maxillary Arch with IZC Bone Screws

Drs. Yu-Hsin Huang, John Jin-Jong Lin & W. Eugene Roberts

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

Drs. Angle Lee, Chris Chang & W. Eugene Roberts

Skeletal Class III Crowded Malocclusion Treated with the Insignia® Custom Bracket System

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2017 iAOI Congress with keynote speaker, Dr. Elizabeth Menzel (center in red) and Chairman, Dr. Chris Chang (center right), Hsinchu, Taiwan.

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張慧男 博士

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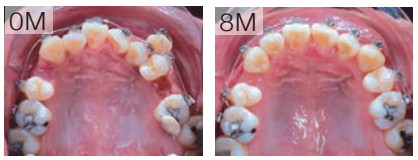
Module 3 - **12/21**



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Dr. Angle's Asian Library and Museum

Preserving the Tradition of Orthodontics for Future Generations.

I have been recently gifted an original Dr. Angle's adjustable molar band from a fellow Angle Society Orthodontist, Dr. Mike Gabler. It was admittedly a huge surprise to receive this and it is something that I will cherish forever. This band was designed and used in Dr. Angle's era and in 1960 this band belonged to the inventor of the famous Kloehn headgear, Silas Kloehn, who passed it on to his son, whose practice Mike Gabler then bought. Now Mike Gabler has decided to retire and he felt that this band should be passed along and inspire others. This fantastic piece of memorabilia is as if the Angle torch is being passed on to me.

Dr. Angle has always been a huge inspiration, it is after reading some articles about Dr. Angle's story that I decided to become an Orthodontist and his teaching example has further inspired me to educate those who are passionate about learning Orthodontics. So, instead of hiding this band away, I intend to use it as a "*torch*" to help cast light on our profession and our founding father's great contributions by establishing Asia's first Angle Orthodontic Library and Museum, which will honor Dr. Angle and allow today's doctors to enjoy, and learn from his and our other predecessors' wisdom.

It is obviously not easy to set up such a venture, but I have been blessed by Dr. Mike Gabler and Dr. Lloyd Pearson, who both have donated their extensive book collections, which document just how much has changed and improved in our profession. Our library section will be for books, but our museum section will preserve this original Angle band, along with other historical equipment, appliances and various Orthodontic paraphernalia.

Of course, I cannot do this all by myself, even though all of my Orthodontic collection will be housed in the library / museum. For those who are interested in selling (*or donating*) their Orthodontic collections, I can arrange for shipping and will pay for all costs. The names of the donator's will be sealed in the books and their names added to an engraved plaque, so all visitors can appreciate their kindness in preserving the history of our profession.

I close by once again thanking Drs. Gabler and Pearson and hope that the Angle library and museum will inspire you and future generations to join us marching on our path to glory.

Chris Chang DDS, PhD, Publisher of IJOI.

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Periodontally-Compromised Class II Malocclusion with Early Loss of Both L6s and the UL3: Class III Elastics for L6 Space Closure and Retraction of the Maxillary Arch with IZC Bone Screws

Abstract

A 42 year old female presented with a periodontally compromised, skeletal Class II Division I malocclusion that was neglected because of concern about the extensive invasive treatment that was previously recommended.

***Diagnosis**: Bilateral full-cusp Class II malocclusion was associated with facial convexity (12º), increased lower facial height (LFH 57%), protrusive maxilla (SNA 83.5º), retrusive mandible (SNB 76º), intermaxillary discrepancy (ANB 7.5º), steep mandibular plane (FMA 44.5º), anterior openbite (2-3mm), increased overjet (7.5mm), deep curve of Spee, missing upper left canine (UR3), bilateral missing lower first molars (LR6, LL6), and an upper dental midline that was deviated 3mm to the left. The Discrepancy Index (DI) was 69.*

***Etiology**: Proximal cause for this severe skeletal malocclusion was the isolated loss of lower first molars in the mixed dentition, which is pathognomonic for Molar-Incisor Hypoplasia (MIH) due to a high fever at <3 years of age. Enamel defects in affected L6s render them susceptible to rapid destruction by caries with subsequent extraction during the mixed dentition. Lack of posterior stops in occlusion when the deciduous second molars exfoliated was a functional anomaly superimposed on an inherent tendency for facial convexity and bimaxillary protrusion. Intermaxillary crowding reflected inadequate functional expansion of the jaws. The maxilla was protrusive but not sufficiently developed in width to accommodate all the teeth. This insufficent space in the upper arch resulted in a blocked-out UL3 and deviation of the upper dental midline to the left. Thus, a combination of inherent and acquired factors produced a severe skeletal malocclusion complicated by asymmetry and periodontal compromise.*

***Treatment**: Periodontal bone loss is a stress-riser in the periodontal ligament (PDL) of orthodontically-loaded teeth. Very light forces (<1N) were applied with flexible CuNiTi archwires in self-ligating brackets. Extraction in the UR4 and implant-supported prostheses to restore the missing L6s were proposed, but the patient desired conservative treatment with no implants or extractions of teeth other than the impacted UL8. Space was closed and alignment was achieved with Class III elastics and differential extra-alveolar (E-A) anchorage provided by infrazygomatic crest (IZC) bone screws to retract the entire maxilla.*

***Results**: This severe skeletal malocclusion (DI 69) was resolved with asymmetric mechanics to close space and correct the maxillary midline. Because of the missing UL3, buccal segments were Class I on the right and Class II on the left. Optimal dental correction to a CRE score of 31 was achieved with 32 months of active treatment. The L6 space closure was not retained with fixed retainers because of the periodontal risk, and the spaces reopened ~1.5mm bilaterally. The patient was well pleased with the dramatic facial and dental improvement, but the skeletal and facial results may have benefitted from additional E-A anchorage screws in the mandibular buccal shelves to intrude lower molars and decrease lower facial height. However, periodontal risk precluded that option.*

***Conclusion**: Increased experience with E-A anchorage in all four quadrants produces dramatic correction of severe skeletal malocclusions without extractions or orthognathic surgery. (Int J Orthod Implantol 2017;47:4-24)*

Key words:

Self-ligation appliance, Class II Division 1, midline off, excessive overjet, missing maxillary canine, early loss of lower molars, Molar-Incisor Hypoplasia (MIH), molar protraction, IZC bone screws, periodontally compromise, constricted maxilla, blocked-out maxillary canine

Dr. Yu-Hsin Huang,
Lecturer, Beethoven Orthodontic Course (Left)
Dr. John Jin-Jong Lin,
Examiner of IJOI, Director of Jin-Jong Lin Orthodontic Clinic (Center)
Dr. W. Eugene Roberts,
Editor-in-chief, International Journal of Orthodontics & Implantology (Right)

History and Etiology

A 42 year female presented with a number of long-term concerns: protrusive maxillary lip, poor dental esthetics and compromised masticatory function (*Fig. 1*). The probable etiology for the acquired aspect of the severe malocclusion was deemed: 1. Molar-Incisor Hypoplasia (*MIH*) due to high fever when she was <3 years old resulted in early loss of both L6s due to caries, 2. Mandibular Retrusion in the late transitional dentition increased the overjet, 3. Clockwise Rotation of the Occlusal Plane due to a lack of posterior centric stops in occlusion in the early permanent dentition increased the lower facial height (*LFH*), 4. Low Tongue Posture increased the axial inclination of the lower incisors, and 5. Inadequate Development of Arch Width reflects low

Fig. 1: Pre-treatment facial and intraoral photographs at 42y5m of age.

masticatory loading due to a refined diet as a child probably related to poor occlusal function (*missing L6s*). Maxillary anterior crowding may have resulted in the maxillary anterior asymmetry as follows: 1. Ectopic loss of the UL deciduous 3 (*ULd3*) when the UL2 erupted, 2. Space closed when the UL4 erupted, 3. UL3 was subsequently blocked out to the labial, and 4. Unesthetic UL3 was extracted (*Figs. 1-3*). The periodontium was subsequently compromised by impactions, tipped teeth and a probable genetic predisposition to periodontitis (*Fig. 3*).

The genetic and developmental problems described were deemed the etiology of the severe, asymmetric Class II malocclusion (*Figs. 1-5*). As an adolescent and young adult, the patient was perplexed by the complexity of the periodontal, surgical and prosthetic treatments proposed. A thorough approach to diagnosis, etiology and comprehensive treatment planning was neglected until reaching 42 years of age.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	83.5°	81°	2.5°
SNB° (80°)	76°	75°	1°
ANB° (2°)	7.5°	6°	1.5°
SN-MP° (32°)	51.5°	52.5°	1°
FMA° (25°)	44.5°	45.5°	1°
DENTAL ANALYSIS			
U1 To NA mm (*4 mm*)	8 mm	1 mm	7 mm
U1 TO SN° (104°)	115°	105°	10°
L1 To NB mm (*4 mm*)	12 mm	9 mm	3 mm
L1 TO MP° (90°)	93°	82°	11°
FACIAL ANALYSIS			
E-LINE UL (*2-3 mm*)	2 mm	-2 mm	3 mm
E-LINE LL (*1-2 mm*)	2.5 mm	-1 mm	2.5 mm
%FH: Na-ANS-Gn (*53%*)	57%	57.5%	0.5%
Convexity: G-Sn-Pg' (*13°*)	12°	11°	1°

Table 1: Cephalometric summary

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

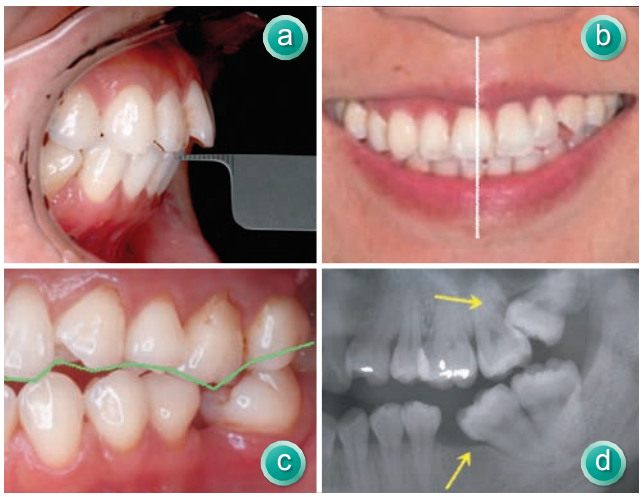


Fig. 3:
The etiology of the acquired malocclusion was a MIH-related loss of the L6s in the mixed dentition, and extraction of the UL3 after it was blocked-out due to underdevelopment of the maxillary arch. The subsequent occlusal development problems were: a. increased overjet due to a functional mandibular retrusion, b. maxillary midline deviation due to blocked out UL3, c. irregular buccal segment due to dental drift and compromised function, and d. osseous defects secondary to mesial inclination of molars (yellow arrows). See text for details.

Diagnosis

Facial:

- Length: *Oval facial form with shorter upper lip*
- Protrusion: *Convex profile with protrusive lips*
- Symmetry: *Maxillary dental midline 3mm to the left, occlusal plane cant (5mm inferior on the patient's right side)*
- Smile: *Gingival exposure has an asymmetric elevation on the right side consistent with the occlusal cant*

Skeletal:

- Intermaxillary Relationship: *Protrusive maxilla (SNA 83.5°), retrusive mandible (SNB 76°), and intermaxillary skeletal discrepancy (ANB 7.5°)*
- Mandibular Plane: *Steep (SN-MP 51.5°, FMA 44.5°) (Fig. 4 & Table. 1)*
- Vertical Dimension of Occlusion (*VDO*): *Na-ANS-Gn (57.5%) which is substantially greater than normal (~53%).*
- Symmetry: *Within normal limits (Figs. 4 and 5)*

Dental:

- Classification: *Full cusp bilateral Class II relationship*
- Overbite: *0 to -2mm*
- Overjet: *7.5mm*
- Missing/Unerupted: *LR6, LL6 and UL3 previously extracted, UL8 impacted (Fig. 5)*
- Symmetry: *Upper midline deviated 3mm to left, occlusal plane cant (Fig. 1)*

The ABO Discrepancy Index (*DI*) was 69 as documented in Worksheet 1 at the end of this report.

Specific Objectives of Treatment

Treatment objectives were to: 1. correct the facial profile, 2. align the upper dental midline. and 3. restore lower posterior occlusion.

Fig. 4:
Pre-treatment lateral cephalometric radiography reveals the classic signs of acquired malocclusion secondary to the early bilateral loss of L6s due to MIH: mandibular retrusion, increased overjet and deep curve of Spee.

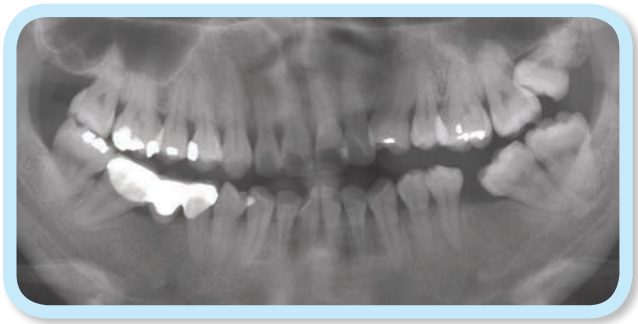


Fig. 5:
Pre-treatment panoramic radiograph shows the morphology of a functionally compensated occlusion on the right side, compared to long-term occlusal dysfunction on the left side.

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

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

Maxillary Dentition:

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

Mandibular Dentition:

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

Facial Esthetics:

- Retract both the upper and lower lips

Treatment Alternatives

The conventional approach previously presented to the patient for management of this periodontally compromised, partially edentulous, skeletal malocclusion was: 1. align the dentition over the apical base of bone, 2. correct skeletal and facial discrepancies with orthognathic surgery, and 3. restore edentulous spaces with implant-supported prostheses. The patient declined the treatment plan because she was concerned about the risks and morbidity of surgery.

A second opinion was sought to limit the surgical risk. Three increasingly challenging treatment plans were devised to manage her dental and facial needs without orthognathic surgery (*Fig. 6*):

1. **Tx Plan 1**: Extract UR4, close space for upper midline correction, orthodontic preparation and bone augmentation of L6 implant sites, and then restore the edentulous spaces with implant-supported prostheses.

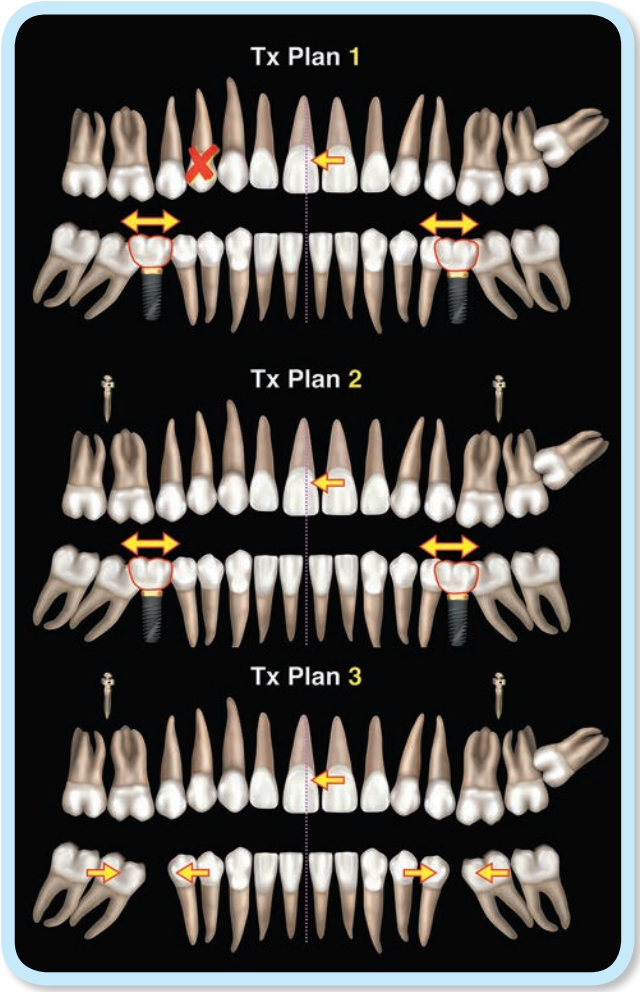


Fig. 6:
Treatment alternatives are ranked from Tx Plan 1 to 3 according to the clinical challenge presented.

2. **Tx Plan 2**: The same as Tx Plan 1 except delete the UR4 extraction, and correct the maxillary arch asymmetry with bilateral IZC screws.[1]

3. **Tx Plan 3**: The same as Tx Plan 2 except close the L6 spaces with Class III elastics and delete the implants.

The patient preferred the most conservative option (*Tx Plan 3*) despite the probability of a longer treatment time and the risk associated with extensive movement of periodontally compromised teeth. She agreed to periodontal treatment before orthodontics and to a careful long-term maintenance program after active treatment.

Treatment Progress

Pre-treatment preparation for 6 months was performed by a periodontist. During this period, the LR fixed prosthesis was removed and provisional treatment crowns were cemented on the abutments. Following pretreatment periodontal preparation, an 0.022-in slot passive self-ligating (*PSL*) appliance with standard torque brackets (*Damon Q®, Ormco, Glendora, CA.*) was bonded on all teeth in both arches, except for the LR lateral incisor. The latter was excluded because space opening with an open coil spring was required prior to bonding (*Fig. 7*). All archwires, elastics and elastomeric chains (*power chain*) were supplied by the same manufacturer.

Over the initial 5 months of the treatment, copper-nickel-titanium (*CuNiTi*) archwires progressed from 0.013-in to 0.016-in for both arches (*Fig. 8, Archwire Sequence Chart at the end of this report*). Two IZC bone screws were placed buccal to the U7s to engage

Fig. 7:
***Upper**: E-A IZC bone screws are shown in the right and left posterior maxilla.*
***Lower**: Right and left buccal views show 0.014-in CuNiTi archwires, with power chains delivering light compressive forces from the IZC 7 screws to the U4s.*

thicker bone.[1] Elastic chains anchored by the bone screws were connected to the upper first premolars bilaterally, to reduce the overjet from the beginning of active treatment (*Fig. 9, 1M*). One month later the right IZC screw loosened and was replaced. Overall progress at three months (*3M*) is shown in Fig. 9. In order to correct the lateral openbite, cross elastics (*Fox 1/4-in, 3.5-oz*) were placed from the buccal side of the upper left premolar to the lingual side of the lower left premolar in the 5th month. The following month (*6M*) the main archwires were changed to 0.014x0.025-in CuNiTi, and power chain was used to consolidate the upper anterior segment. One month later, when the 0.018x0.025-in CuNiTi archwire was placed, space was noted distal to the LR3, so intra-arch elastics (*Fox 1/4-in, 3.5-oz*) were applied to maintain constant force, but also allow good access for oral hygiene. Due to the outstanding retraction efficiency of the IZC screws, the overjet was completely corrected end-to-end at nine months (*9M in Fig. 9*). To recover a normal overjet relationship, Class III elastics (*Fox 1/4-in, 3.5-oz*) were

applied from 8-14 months (*Kangaroo 13/16-in, 4.5-oz*) and retracted lower incisors simultaneously with the upper incisors. After 10 months of active treatment, the impacted UL8 was extracted and the lower archwire was changed to 0.016x0.025-in stainless steel (*SS*). The lower posterior spaces were closed with powerchain of the lower archwire and Class III elastics (*Fig. 10*). After 16-months, the lower residual spaces were closed and the lower molars were aligned (*Figs. 8 and 10*). After the anterior spaces were closed, inter-proximal reduction (*IPR*) was performed on the lower and upper incisors to improve coronal contours and proximal contacts, as well as for eliminating black triangles.[2] Kangaroo elastics (*13/16-in, 4.5-oz*) were applied for posterior crossbite correction and space closure was maintained with elastic chains securing 0.014x0.025-in or 0.018x0.025-in CuNiTi archwires. In the 21st month, the LL8 was rebonded for rotation correction. Two months later (*23M*) bracket positions of the upper anterior six teeth were reset to a more gingival position to deepen the anterior overbite (*Fig. 9*). One month later power chains were maintained to retain space closure, while diagonal and intra-arch elastics

Fig. 8:
A progressive series left buccal views from the start of treatment (0M) to twenty-one months (21M) document alignment of both arches and maxillary retraction with power chains anchored with E-A IZC bone screws. See text for details.

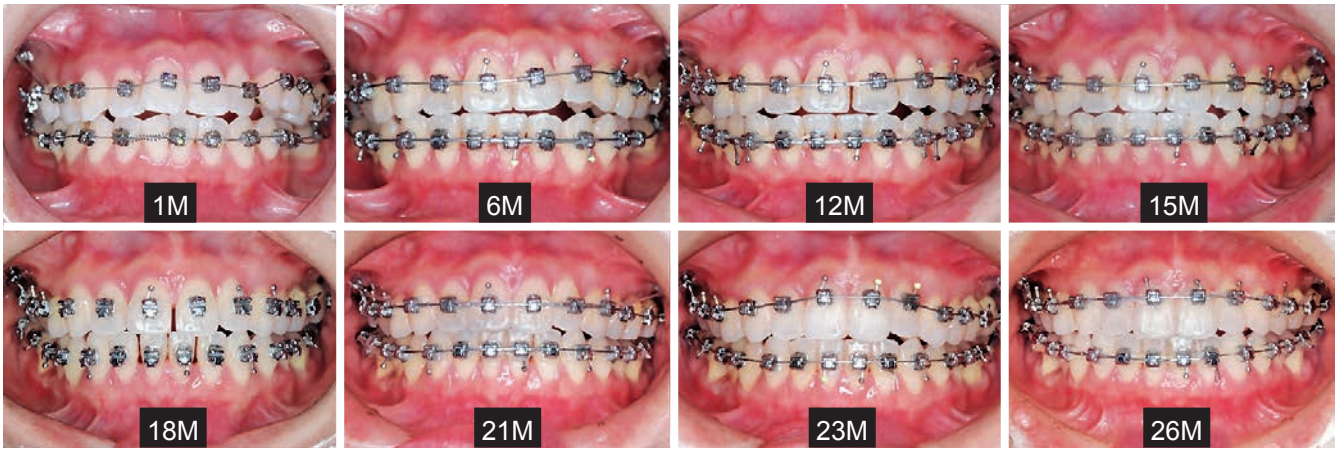


Fig. 9:
Frontal views of the arches from zero (0M) to twenty-six months (26M) show the extensive tooth movement. Upper incisor brackets were repositioned in a gingival direction at 23M to correct the overbite. See text for details.

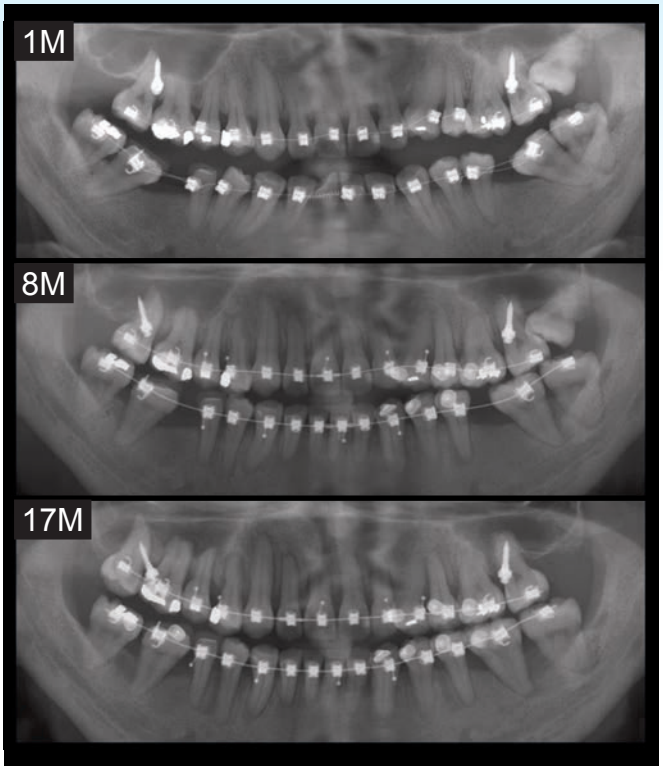


Fig. 10:
Panoramic radiographs at 1, 8 and 17 months (1M, 8M, 17M) show the positions of the IZC bone screws, extraction of the UL8, and bilateral closure of the L6 spaces. Note the change in the orientation of the right IZC bone screw; it failed and was replaced two months into treatment. See text for details.

(*Kangaroo 3/16-in, 4.5-oz*) were applied simultaneously. At 25 months into treatment, an 0.016x0.025-in stainless steel (*SS*) archwire was placed for 3 months to level the occlusal plane. Crossbite correction was continued with Kangaroo elastics (*3/16-in, 4.5-oz*) after 24 months of Class II sagittal correction (*Fig. 11*). Once the posterior transverse problem was resolved, the final detailing for midline correction and occlusal settling was accomplished with triangular elastics applied in an oblique direction (*Fox 1/4-in, 3.5-oz*) (*Fig. 12*).[3,4] After 32 months of active treatment, all fixed appliances were removed. (*Figs. 13,14 &15*).

The archwire sequence chart at the end of the report provides details for the timing, size and materials for all archwires and elastics used. It is important to note that all archwires were CuNiTi except for relatively small rectangular 0.016x0.022-in SS in the lower arch during two intervals: 1. eight months (*9-17M*) when Class III elastics were used to close the L6 spaces, and 2. three months (*25-28M*) to complete leveling of the curve of Spee and to assist with correction of

Fig. 11:
Twenty-four months into treatment cross-elastics were applied from the buccal brackets on the upper premolars and molars (upper) to the lingual buttons on the lower molars and premolars (below). See text for details.

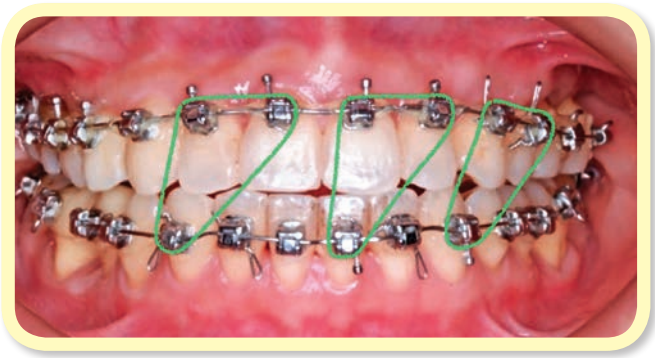


Fig. 12:
Triangle intermaxillary elastics are oriented diagonally to correct the upper midline discrepancy during the final stage of active treatment.

Fig. 13: Post-treatment facial and intraoral photographs

Fig. 14: Post-treatment dental models (casts)

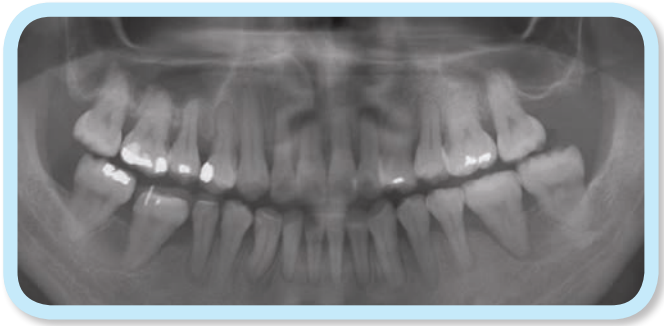


Fig. 15: Post-treatment panoramic radiograph

Fig. 16: Post-treatment lateral cephalometric radiograph

the posterior crossbite tendency (*Fig. 11*). For a fixed appliance with 0.022-in slots, these were all relatively light archwires that did not exceed 1N of force to any tooth during active treatment. The Archwire Sequence Chart at the end of this report reflects the low force treatment plan for a periodontally compromised dentition.

Results achieved

The periodontally compromised, severe skeletal malocclusion (*DI 69*) was corrected to a markedly improved facial and dental result (*CRE of 31*) with 32 months of active treatment as documented in Worksheet 2 at the end of this report. Maxillary lip protrusion was well addressed by retraction of the entire maxillary dentition, but the LFH (*VDO*)

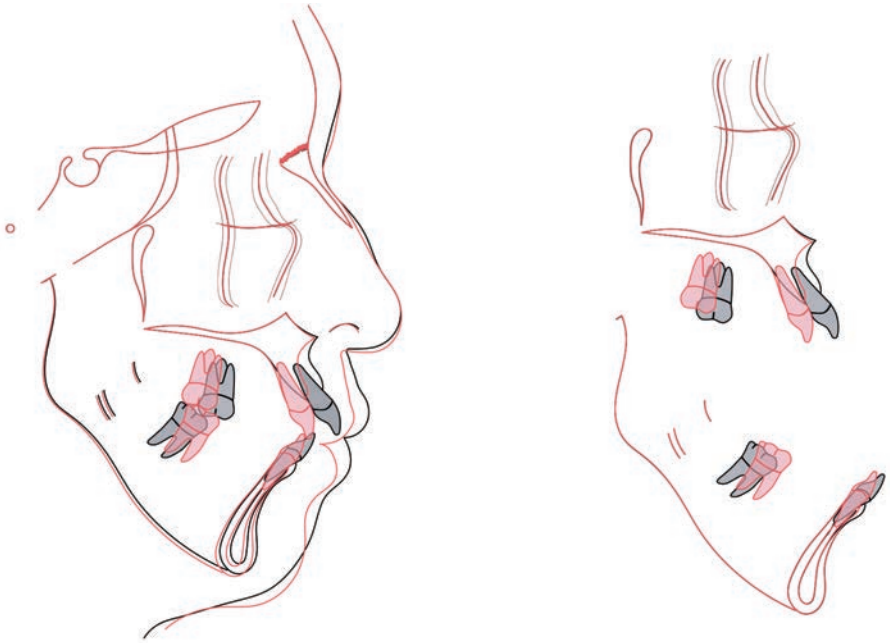


Fig. 17:
Superimposed cephalometric tracings showing dentofacial changes achieved with 32 months of active treatment (red) compared to the pre-treatment position (black). The protrusive lips have been corrected, resulting in a more balanced lower facial profile. The maxillary arch was retracted and rotated anteriorly (clockwise). The lower arch was leveled and aligned, while the missing L6 spaces were closed with CIII elastics (U6s to L3s bilaterally). Retrospective assessment reveals that the lower facial height could have been decreased by intruding the lower molars with lower posterior MBS bone screws, but intruding periodontally compromised teeth is risky. See text for details.

was opened 0.5%, which increased the FMA, SN-MP and SNB angles 1°. Despite the pleasing result for correction of a severe malocclusion, the facial convexity and mandibular retrusion remained excessive (*Figs. 16 and 17, Table 1*). The maxillary midline discrepancy was corrected, and the occlusal cant in the frontal plane was decreased (*Figs. 13-15*). The specific treatment objectives are outlined below.

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

- A - P: *Retracted slightly*
- Vertical: *Opened slightly*
- Transverse: *Maintained*

Maxillary Dentition

- A - P: *The entire arch was retracted*
- Vertical: *Incisors were maintained but molars were intruded*
- Inter-molar / Inter-canine Width: *Maintained / Maintained*

Mandibular Dentition

- A - P: *Uprighted and retracted incisors, molars protracted for space closure*
- Vertical: *Molars uprighted and extruded*
- Inter-molar / Inter-canine Width: *Maintained / Maintained*

Facial Esthetics

- Normal lip profile was achieved, but the face remained long and convex (*Figs. 16 &17*)

Retention

Consistent with hygiene maintenance, the only retention was an upper Hawley and lower anterior spring retainers. To avoid plaque accumulation, no fixed retainers were placed. The patient was instructed in proper home hygiene as well as for long-term maintenance of the removable retainers. Retainer wear was full time for the first 6 months and nights only thereafter.

Final Evaluation of Treatment

Substantial improvement in the lip profile, dentition alignment and occlusal function were achieved. The ABO Cast-Radiograph Evaluation (*CRE*) was a total of 31 points.[5] The most prominent alignment deficiencies were buccolingual inclinations (*10 points*), marginal ridges discrepancies (*6 points*), lack of occlusal contacts (*4 points*) and overjet (*3 points*) (*Figs. 13-15*). See Worksheet 2 at the end of this report for CRE scoring details. The Pink & White (*P&W*) dental esthetic score was 5 points primarily because of the UL4 substitution for the missing UL3. See Worksheet 3 at the end of this report for P&W scoring details.

Free gingival graft surgery is indicated to improve the gingival recessions on the labial of the lower posterior teeth.[6] Although the extensive orthodontic treatment resolved the patient's chief complaints, the potential for long-term periodontal problems may affect long-term maintenance and stability. To avoid compromising the marginal periodontal

health of the protracted L7s, no fixed retention was utilized to maintain L6 space closure. Relapse of about 1.5mm of space opening occurred between the L5s and L7s, six months after fixed appliances were removed. Repeated space closure of missing L6 spaces is not warranted because there are no natural transeptal fibers between L5s and L7s.[7,8] If the relapsed spaces prove to be problematic, it is best to close the space restoratively as follows: 1. place separators in the interproximal areas mesial and distal to the relapsed space in the L6 area to distribute the spaces throughout the lower buccal segments, and 2. restore all interproximal contacts with restorative resin.[7,8]

Discussion

Loss of permanent teeth often results in minor problems such as spacing, tooth rotation, tilting, and migration of teeth into an edentulous space. However, missing a L6(*s*) during the transitional dentition (*<10yr of age*) exposes children to severe acquired malocclusion. When the second deciduous molars exfoliate at age 10-12, there is no posterior centric stop in occlusion on the affected side(*s*).[9,10] MIH-related loss of mandibular first molars is a common etiology for acquired Class II malocclusion, either unilateral of bilateral. Early loss of both mandibular first molars in the mixed dentition often results in a characteristic acquired malocclusion (*Fig. 4*): 1. mesially tipped second molars, 2. deep curve of Spee, 3. mandibular retrusion, and 4. decreased axial inclination of maxillary incisors, with deep-bite and/or increased overjet.[11]

When there is an abrupt loss of posterior occlusion in the late transitional stage of occlusal development, children posture the mandible anteriorly or posteriorly for occlusal function. The direction of mandibular compensation depends on the incisal relationship and the succedaneous teeth in occlusion.[12] The MIH-related scenario for the present patient was a mandibular retrusion and forward (*clockwise*) rotation of the occlusal plane resulting in an anterior openbite, increased VDO and a steep mandibular plane angle (*MPA*) (*Figs. 1-5*).

Missing L6 spaces requires a differential diagnosis to choose the optimal treatment plan for each site. If the L8 is present in the affected quadrant, space closure is often the best option, but when the L8 is absent, space opening and an implant-supported crown to restore the missing L6 is preferable. Defining the etiology of an acquired malocclusion is important for understanding the potential of a functionally retruded mandible to readapt (*"grow"*) into a more anterior position or for protraction of the remaining molars to close the space (*Figs. 10 and 17*).[11]

Asymmetry was a challenging complication (*Figs. 1-3*) that required careful consideration of the etiology for each asymmetric component. The options are to correct, accept or mask the undesirable morphology. Etiology is an important consideration for conservative correction of mandibular retrusion and/or lower posterior space closure as part of a comprehensive treatment plan. The history of previous dental treatment is an additional factor. The LR6 was previously restored with a three-unit fixed prosthesis probably because there was less tipping, no impactions and the maxillary canine was present on the right side (*Figs. 1-3*). The patient may

have an inherent right side chewing preference, but she certainly chewed on the right side after the edentulous space was restored as a young adult (*Fig. 5*). Thus, at age 42 numerous form and function anomalies associated with poor occlusal function had accumulated on the left side: 1. missing UL3, 2. maxillary midline deviation, 3. canted occlusal plane, 4. severely tipped LL7, and 5. openbite in the lateral incisor and premolar areas. A full fixed PSL appliance with IZC bone screw anchorage corrected or at least improved all of the alignment problems, but there was still a residual cant to the occlusal plane and an openbite tendency in the left premolar area. Although complete correction of the cant was possible with differential use of IZC anchorage, the additional maxillary intrusion was not warranted for a periodontally compromised patient (*Fig. 13*). The openbite tendency reflects a tongue posture problem that is probably related to the established preference for chewing on the right side (*Figs. 13 and 14*). Patients who preferentially chew on one side may compensate for the mandibular torsion on the balancing side with tongue-bracing, which may be manifest as a lateral openbite tendency.[13]

As described in the etiology section, a blocked-out maxillary canine is often a manifestation of crowding, reflecting a tooth-size to arch length discrepancy. When space is limited, emerging permanent teeth infringe on adjacent primary teeth resulting in premature exfoliation and closure of the space. Since the U3s are typically the last succedaneous teeth to emerge, they often erupt high in the labial fold because there is no room in the arch, i.e. they are "*blocked-out.*" Unilateral blocked-out U3s are often associated with maxillary midline deviations (*Figs. 1-3*), and a bilateral manifestation usually reflects severe crowding and/or anterior crossbite.[12,14] With traditional mechanics a blocked-out U3 usually requires extraction of an adjacent premolar to achieve desired form and function. However, differential IZC anchorage provides the mechanics to correct these challenging problems without extraction(*s*).[15,16]

Nonextraction correction of facial protrusion with E-A bone screw anchorage usually follows a typical pattern as shown in Fig. 18. For the first few months of treatment, lip protrusion increases as the crowding and axial inclination of the incisors are corrected (*1-*

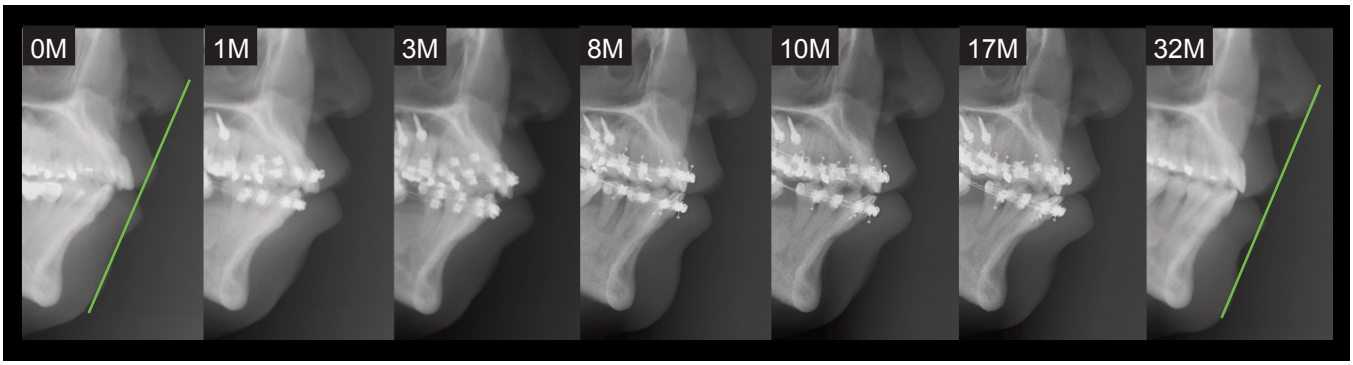


Fig. 18:
A progressive series of cephalograms from zero to thirty-two months (0-31M) shows the dental and lip relationships as the maxillary arch is retracted with IZC anchorage. Note there is increased bimaxillary protrusion during initial alignment (3M), and the overjet is end-to-end by 8M. Lower posterior space closure and continued maxillary retraction resulted in a pleasing lip profile at the end of treatment (32M). See text for details.

3M, *Fig. 18*). Lip protrusion is progressively decreased as the arches are retracted (*8-32M, Fig. 18*). It is important for patients to understand the treatment sequence so that they can consciously maintain lip competence throughout the process. If lip competence is lost during treatment there can be anterior tongue posturing and a dramatic increase in lower facial height, particularly if the mechanics include intermaxillary elastics.

As presently defined, the IZC is the inferior aspect of the zygomatic process of the maxilla. The process terminates as a ridge on the buccal aspect of the alveolar process between the first and second molars, so the most convenient bone screw sites are subdivided into IZC 6 or IZC 7, respectively (*Fig. 19*).[15] Because the cortical plate of bone is near the buccal roots of the molars, IZC bone screws are typically inserted with an inclination of 55-70°, relative to the lateral surface of the maxilla. This orientation allows the screw to pass buccal to the molar roots and then

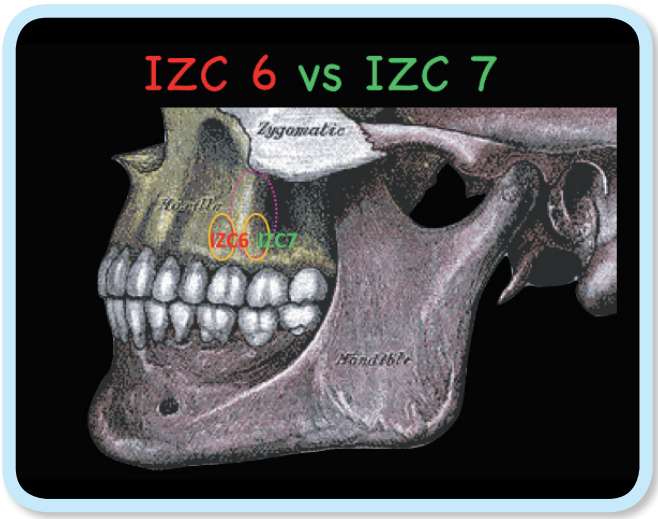


Fig. 19:
The zygomatic process of the maxilla emerges as a ridge (pink oval) from the superior aspect of the alveolar process between the U6 and U7. The most desirable sites for IZC bone screws are anterior (IZC 6) or posterior (IZC 7) to the ridge (pink circle). See text for details.

Fig. 20:
An anterior-posterior radiograph of the head shows the E-A position of the IZC bone screws. This relationship is important to avoid impingement on molar roots and to permit retraction of the entire maxillary arch en masse. See text for details.

penetrate the thick bone superior to the molars. Since the IZC screws are lateral to the the roots of the molars, they are in an extra-radicular or extra-alveolar (*E-A*) location relative to the alveolar bone supporting the roots of the maxillary molars (*Fig. 20*).[16] Compared to inter-radicular (*I-R*) miniscrews placed in the restricted space between the roots of the teeth,[17] E-A bone screws are longer (≤*14mm*), larger in diameter (*2mm*), and made of a tougher non-brittle material (*stainless steel*).

The amount of bone on the buccal surface of the IZC is highly variable. In general, bone thickness in the IZC 7 area is greater than for IZC 6, so a bone screw is less likely to impinge on the root of a tooth.[18] In addition, the present patient had a low sinus floor that tended to dip between the teeth in the posterior maxillary segments. It was necessary to place the IZC bone screws buccal to the crown of the molars which is the most desirable position to allow the molars to move mesially or distally (*Fig. 21*). There was considerably less bone in the IZC area on the right side compared to the left which was

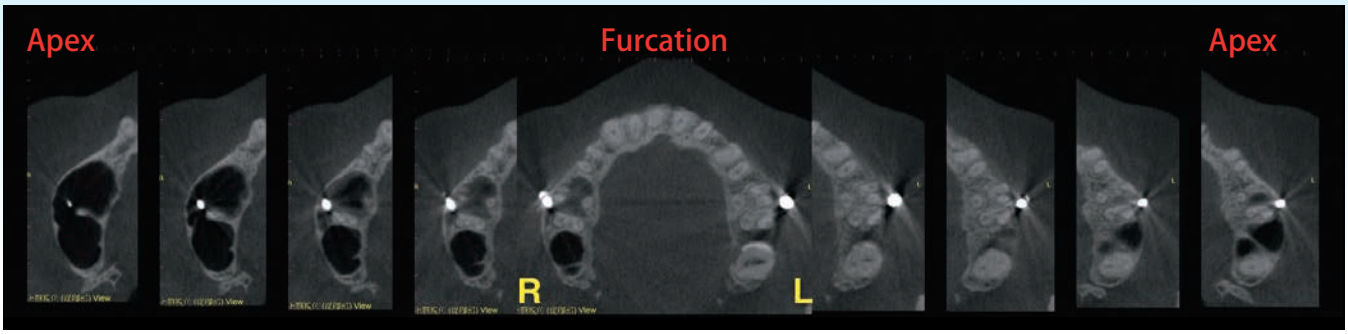


Fig. 21:
Axial cone-beam computed tomography cuts from the furcation (center) to the apex levels of the U7s show the available bone for IZC bone screws. Note that the descending maxillary sinus on the right side (R) compromises the available bone. Much of the right IZC bone screw is in or near the sinus. Although the first bone screw in the right IZC region failed after two months, it was successfully replaced in an adjacent location. See text for details.

probably a factor in the failure of the right IZC screw at two months into treatment.

Chang et al.[19] found that IZC bone screws have a low failure rate (<7%) which increased clinical confidence that IZC anchorage was adequate for correcting the maxillary midline discrepancy without extracting the UR4 (*Fig. 6*). However, the right IZC screw did fail at two months into treatment. It may be challenging to find an adequate adjacent site to replace a failed IZC screw. To help control IZC bone screw failure, the clinician must consider the following factors relative to the operative site: 1. a low sinus floor is associated with thin buccal bone, 2. young patients often have soft (*poorly mineralized*) bone, 3. excessive force must be avoided when screwing in the bone screw, 4. unstable screws present a "*drop-in sensation*" when inserted which is often a prelude to failure, 5. select an alternate site that maintains the initial angulation of the bone screw, and 6. place a palatal or mandibular buccal shelf (*MBS*) bone screw if bone in the IZC site is inadequate. Despite the relatively thin bone (*Fig. 21*) it was possible to reposition the right IZC bone screw to obtain adequate anchorage. It is clear that bone screws carefully installed in sites with low bone mass can provide good orthodontic anchorage.

The UL8 was horizontally impacted distal to the UL7 (*Fig. 5*). It was preferable to extract the impaction before commencing orthodontic treatment, but the patient was hesitant and requested a delay. The UL8 was not removed until 10 months into treatment. Despite the nearby surgery, the left IZC screw remained stable.

Occlusal irregularity in a partially edentulous patient often requires preprosthetic alignment. Intruding teeth is a concern for periodontally compromised patients, so reduction of crown height and endodontics may be preferable to orthodontic intrusion.[20] Evaluating edentulous ridge quality and quantity, relative to post-operative healing, is an important consideration for treatment planning. It is best to perform preprosthetic alignment as soon as possible because the alveolar ridge may decrease 40% in height and 60% in width during the first 6 months after tooth extraction.[21] Ridge atrophy continues but at a slower pace ultimately resulting in a dense, knife-edge ridge of cortical bone that is

difficult to resorb for space closure.[22] Atrophic ridges usually require bone augmentation before placing an implant.[23] For implant-site development, the length of the space is increased to 6mm or more with an open coil spring.[24] The ridge width and osseous contours are restored with a guided bone regeneration procedure.[25-27]

Three alternative treatment plans were considered (*Fig. 6*). The first two approaches featured implant-supported prostheses to restore the missing L6s. However, the MIH-related etiology of the malocclusion was consistent with good mesial movement potential for the L7s and 8s, either by more anterior posturing of the mandible or via tooth movement.[11] Despite the clinical challenge, lower 6 space closure was the patient's preference (*Tx Plan 3, Fig. 6*). Previous experience with conservative treatment of MIH-related acquired malocclusions[9-12] indicated space closure was a viable option, but previous reports by Roberts et al.[7,8,28] were a concern. That data indicated that lower molars have extremely high anchorage value because of the dense bone formed by the leading root when a L7 is moved mesially with conventional mechanics (*loads up to 3N per quadrant*). However, the current experience closing L6 spaces with light force (*<1N*) on flexible CuNiTi or small diameter SS archwires suggests that light loads superimposed on function are indicated for mesial movement of lower molars.[9-12,20,22,23]

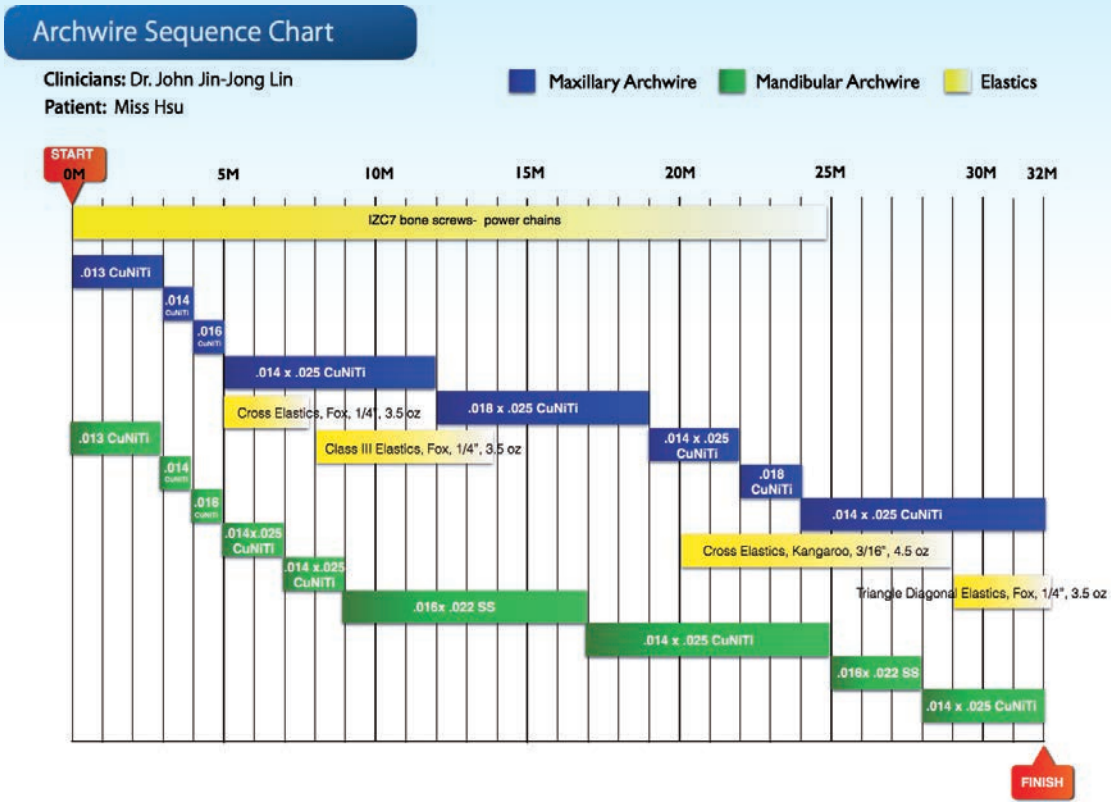
Controlling PDL stress by moving arches as segments enhances the rate of tooth movement and decreases the incidence of root resorption.[29] Control of PDL necrosis with segmental mechanics and/or multi-force archwires delivering lower loads with an increased range of action promises to deliver rates of tooth movement that are approaching the theoretical limit for osteoclast mediated bone resorption: 30-40µm/day or ~1mm/mo.[30,31]

There are three keys for successfully uprighting tipped mandibular molars and closing spaces in periodontally compromised patients:

1. Apply light continuous force to PSL brackets with CuNiTi archwires.
2. Level and align the upper arch early in treatment to avoid occlusal prematurities as lower molars are uprighted.
3. Adjust occlusal prematurites on mobile lower molars with bracket repositioning or enamel adjustment.

Conclusion

Periodontally compromised patients with skeletal malocclusions, acquired by an MIH-related loss of lower first molars during the mixed dentition, may have excellent dentofacial orthopedic potential for conservative correction, i.e. without extractions or orthognathic surgery. Carefully evaluate the periodontium and etiology of the malocclusion to devise a realistic treatment plan. To minimize PDL stress, it is advantageous to use a 3D digital bracket placement system, and multiple-force archwires with a wide range of activation for initial leveling. Avoid unnecessary adjustments that produce elevated PDL stress and necrosis: progressive archwires, bracket rebonding, and archwire detailing. Particularly for periodontally compromised patients, a PSL bracket system with light forces (*<1N*) delivered by CuNiTi or small rectangular SS archwires is indicated.



Use E-A bone screws in the posterior maxilla and mandible as needed to align the dentition in 3D over the apical base of bone. Control the facial height and protrusion by retracting, rotating and intruding the arches, as needed. The general rule for L6 edentulous areas is to close the space if the L8 is present, but if the L8 is missing open the space for an implant-supported prosthesis. Level and align the maxillary arch prior to closing space by protracting the L7s and 8s. The current patient was pleased with the dramatic improvements in lip profile and dental alignment (*Fig. 22*). However, the result could have been improved with intrusion of the lower molars to produce forward rotation of the mandible and deceased lower facial height, but intrusion of periodontally compromised teeth is risky. Clinicians are increasingly appreciating the potential for low PDL stress and orthopedically anchored mechanics for patients with a healthy periodontium. Routine correction of even severe acquired malocclusions is on the horizon.

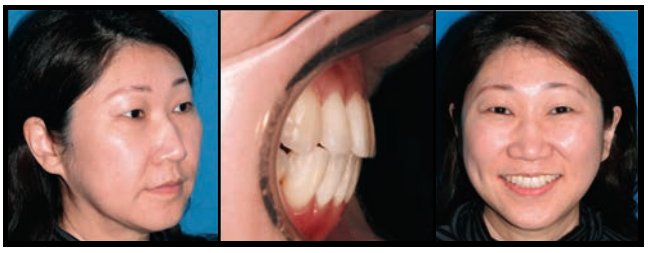


Fig. 22:
Facial and overjet photographs show the pleasing final result.

Acknowledgment

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 69

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. 7.5mm
> 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 = 7

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 2

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

5.5 mm (upper)

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 8 pts.
Beyond Class II or III	=	1 pt. per mm. additional ____ pts.

Total = 8

Bilateral Full Class II

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° 7.5° = 4 pts.

Each degree < -2° ____ x 1 pt. = ____

Each degree > 6° 1 x 1 pt. = 1

SN-MP 51.5°

≥ 38° = 2 pts.

Each degree > 38° 13 x 2 pts. = 26

≤ 26° = 1 pt.

Each degree < 26° ____ x 1 pt. = ____

1 to MP ≥ 99° = 1 pt.

Each degree > 99° ____ x 1 pt. = ____

Total = 33

OTHER (See Instructions)

Supernumerary teeth	____ x 1 pt. =	____
Ankylosis of perm. teeth	____ x 2 pts. =	____
Anomalous morphology	____ x 2 pts. =	____
Impaction (except 3rd molars)	____ x 2 pts. =	____
Midline discrepancy (≥3mm)	@ 2 pts. =	2
Missing teeth (except 3rd molars)	3 x 1 pts. =	3
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	3 x 2 pts. =	6

Identify: Molar protraction x2
Periodontal compromised x1

Total = 11

IMPLANT SITE

Lip line : Low (0 pt), Medium (1 pt), High (2 pts) =_

Gingival biotype : Low-scalloped, thick (0 pt), Medium-scalloped, medium-thick (1 pt) High-scalloped, thin (2 pts) =_

Shape of tooth crowns : Rectangular (0 pt), Triangular (2 pts) =_

Bone level at adjacent teeth : ≤ 5 mm to contact point (0 pt), 5.5 to 6.5 mm to contact point (1 pt), ≥ 7mm to contact point (2 pts) =_

Bone anatomy of alveolar crest : H&V sufficient (0 pt), Deficient H, allow simultaneous augment (1 pt), Deficient H, require prior grafting (2 pts), Deficient V or Both H&V (3 pts) =_

Soft tissue anatomy : Intact (0 pt), Defective (2 pts) =_

Infection at implant site : None (0 pt), Chronic (1 pt), Acute(2 pts) =_

Total = 0

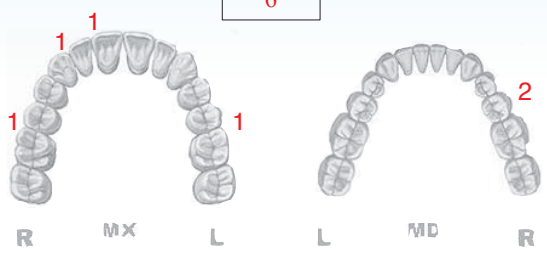
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 31

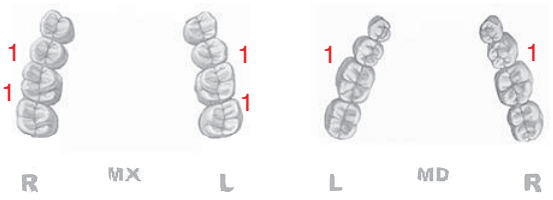
Alignment/Rotations

6



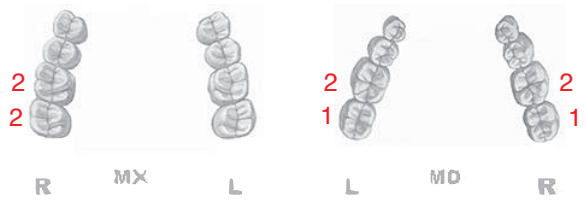
Marginal Ridges

6



Buccolingual Inclination

10

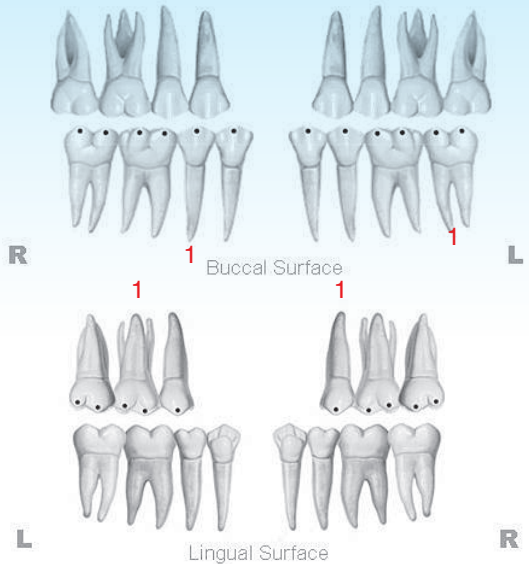


Overjet

3

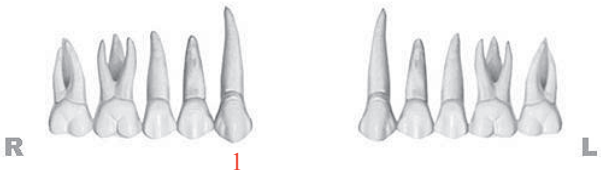
Occlusal Contacts

4



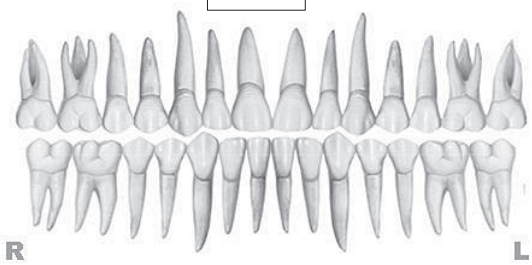
Occlusal Relationships

1



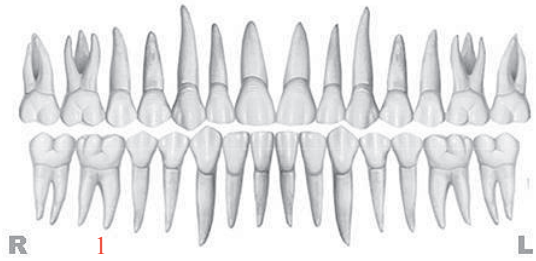
Interproximal Contacts

0



Root Angulation

1



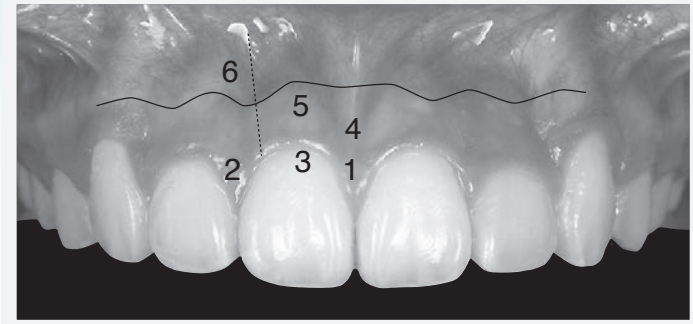
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 5

1. Pink Esthetic Score

Total = 2

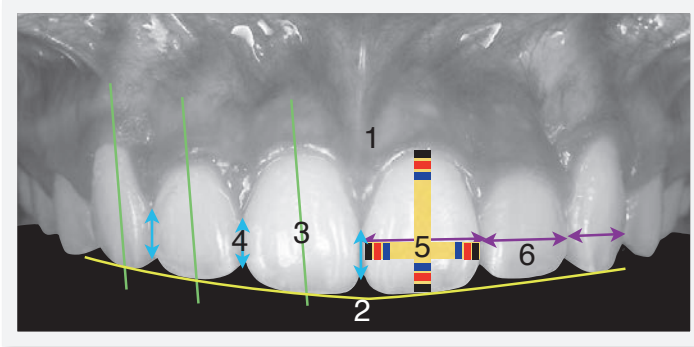


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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

2. White Esthetic Score (for Micro-esthetics)

Total = 3



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

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

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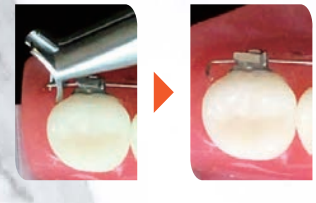


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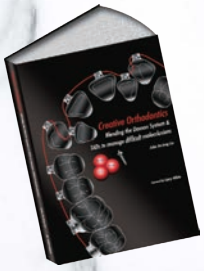

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MIH-Related Loss of Mandibular First Molars Resulted in an Acquired Class II Skeletal Malocclusion: Conservatively Treated with Space Closure on One Side and Implant-Supported Prosthesis on the Other

Abstract

***Diagnosis**: A 34-year-old female presented with a Class II partially edentulous malocclusion with 4mm of overjet. Cephalometrics revealed a protrusive maxilla with relative mandibular retrusion (SNA 85°, SNB 78°, ANB of 7°). A slightly retrusive lower lip was associated with missing mandibular first molars, mesially tipped second molars, anterior spacing, and abfraction on the buccal surfaces of the lower premolars. This developmental (acquired) malocclusion is typical for bilateral Molar-Incisor Hypoplasia (MIH).*

***Etiology**: The isolated loss of the first molars in an otherwise healthy dentition is pathognomonic of MIH, usually due to high fever at <3 yr of age. This common childhood problem may result in developmental enamel defects, that render the first permanent molars (6s) highly susceptible to caries soon after eruption. During the late mixed dentition, a bilateral lack of posterior centric stops in occlusion results in a typical pattern of occlusal collapse: mesially tipped second molars, deep curve of Spee, mandibular retrusion, and incisal compensation (increased overjet and/or deep bite).*

***Treatment**: Full-fixed non-extraction treatment was indicated to close the lower right (LR) space, but the lower left (LL) space required preparation for an implant-supported prosthesis because of the missing left third molar. The mesially tipped mandibular molars were uprighted with a copper-nickel-titanium archwire (CuNiTi), open coil springs, and a more gingival orientation of the second molar tubes on the mesial side. During LR space closure, the midline was maintained with an asymmetric Class II elastic in a L-configuration; the elastic coursed from the upper right canine (UR3), passed gingival to the hook on the LR second premolar (LR5) and extended to the LR second molar (LR7). Symmetrical Class II elastics in the same configuration were used bilaterally to resolve the Class II relationship after the LR space was closed. At 17 months of active treatment, an implant was placed to restore the LL6. Following a 6 month healing phase, the implant was uncovered and a healing abutment was placed. To prevent relapse, fixed appliances were not removed until the temporary prosthesis was placed. The final crown was delivered at 23 months.*

***Results**: This difficult malocclusion was treated to an appropriate preprosthetic result in 17 months, and final finishing was achieved after the implant was placed. The cephalometric film documented asymmetric sagittal positions of the TMJs, but transcranial radiographs of the joints in the open and closed positions were within normal limits (WNL). Overall, interdisciplinary treatment for this complex problem with a Discrepancy Index score of 24, was treated to a Cast-Radiograph Evaluation score of 19 and a Pink & White Esthetic Score of 3 in 23 months. At two-year follow-up, occlusal contacts were optimal, the Class I correction was stable, and the profile had continued to improve. All morphology and function was WNL.*

***Conclusions**: MIH can result in challenging symmetric or asymmetric malocclusions that have good potential for conservative skeletal correction. Defining the etiology is an important diagnostic procedure because MIH-related functional retrusion responds well to bite turbos and Class II elastics with an L-configuration. There was no need for functional orthopedics, extractions, temporary anchorage devices, or surgery. (Int J Orthod Implantol 2017;47:26-48)*

Key words:
Molar-Incisor Hypoplasia (MIH), missing first molar, mesially tipped molar, molar uprighting, implant site preparation, asymmetrical mechanics, space management, implant-supported prosthesis

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Introduction

The early loss of permanent 1st molars particularly in the lower arch is associated with a variety of acquired malocclusions that occur after the deciduous second molars exfoliate. Generalized oral hygiene negligence may lead to rampant caries of deciduous and permanent teeth, but the isolated loss of permanent 1st molars is usually related to molar-incisor hypomineralization (*MIH*), a worldwide developmental problem with a prevalence of 10-22%.[1,2] The enamel of the 1st molars develops when children are younger than 3 years of age. Young children commonly spike high fevers up to 104° F (*40° C*) for relatively short periods of time and recover with no apparent problems until the permanent first molars erupt. Elevated fever at <3 years of age may have a deleterious effect on the enamel formation of the first permanent teeth to form: central incisors

Fig. 1: Pre-treatment facial and intraoral photographs

and 1st molars.[1-6] An affected incisor is easily noticed by the parents, but molar hypomineralization is not usually recognized until the child develops a tooth ache after the tooth is destroyed with caries. The "*bombed-out*" first molars are usually extracted at about age 7-9 years. Typically there are no functional problems with occlusion until the 2nd deciduous molars exfoliate. In the absence of posterior centric stops during the late transitional stage of occlusal development (*age 10-12yr*), occlusal collapse and severe acquired malocclusions may occur.[1-4,6]

When a mandibular 1st molar is extracted early, the 2nd and 3rd molars drift mesially into the extraction space. Gingival tissue on the mesial of the second molar may form a plaque-harboring pseudo-pocket that is almost impossible to clean with routine hygiene measures.[7] The objectives of the molar uprighting include: (*1*) eliminate the pseudo-pocket and any associated osseous defects, (*2*) align roots perpendicular to the occlusal plane so that they can optimally withstand the force of occlusion, (*3*) alleviate occlusal trauma, (*4*) correct an excessive curve of Spee, (*5*) improve the crown/root ratios of periodontally involved molars, and (*6*) simplify restorative procedures.[8,9]

Diagnosis and Etiology

A 34yr 6mo female sought orthodontic evaluation with concerns about missing posterior teeth and lower anterior spacing (*Fig. 1*). She had maxillary protrusion (*SNA 85°*) and mandibular retrusion (*SNB 78°*), which resulted in a substantial skeletal discrepancy (*ANB 7°*). There was a slightly retrusive

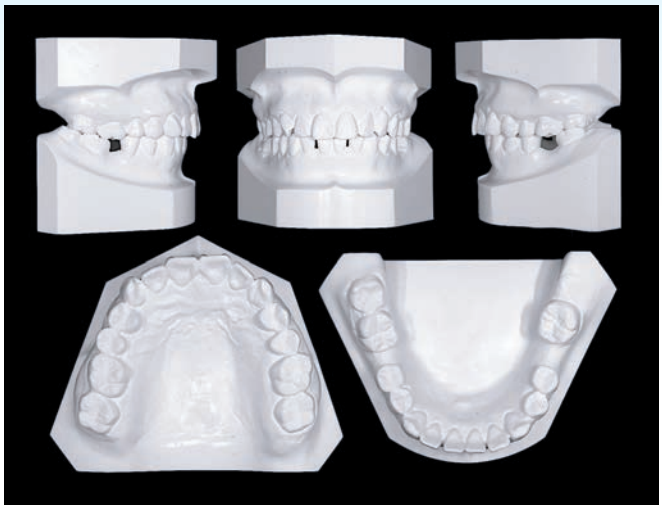


Fig. 2: Pre-treatment dental models (casts)

Fig. 3:
Frontal view of the mandibular dentition shows anterior spacing.

Fig. 4:
Inferior (left) and lateral (right) views of the incisors show the 4mm overjet and 4mm overbite.

lower lip that was associated with ~5mm Class II occlusion at the canines, 4mm overjet, decreased

axial inclination of the maxillary incisors, 3mm maxillary anterior crowding, and 2-3mm of anterior spacing in the lower anterior segment (*Figs. 2-4*). Non-carious cervical lesions due to functional overload and/or improper brushing were noted on the premolars. In addition, the overbite and overjet were both 4mm (*Figs. 4 and 5*). The upper dental and facial midlines were coincident, but the lower dental midline was 1mm to the right (*Figs. 1 and 4*).

For this case report quadrants will be designated upper right (*UR*), upper left (*UL*), lower right (*LR*), and lower left (*LL*), and teeth in each quadrant are numbered 1-8 relative to the midline. The pre-treatment panoramic radiograph showed both lower first molars (*LR6 and LL6*) were missing, second molars (*LR7 and LL7*) were tipped mesially into the atrophic spaces, and the only third molar present was in the LR quadrant (*Fig. 6*). Cephalometric radiography (*Fig. 5*) revealed a relatively symmetric mandible, but transcranial views of the temporomandibular joints (*TMJs*) showed the right condyle inferiorly positioned in the fossa when the mandible was closed (*Fig. 7*).

Fig. 5: Pre-treatment lateral cephalometric radiograph

Fig. 6: Pre-treatment panoramic radiograph

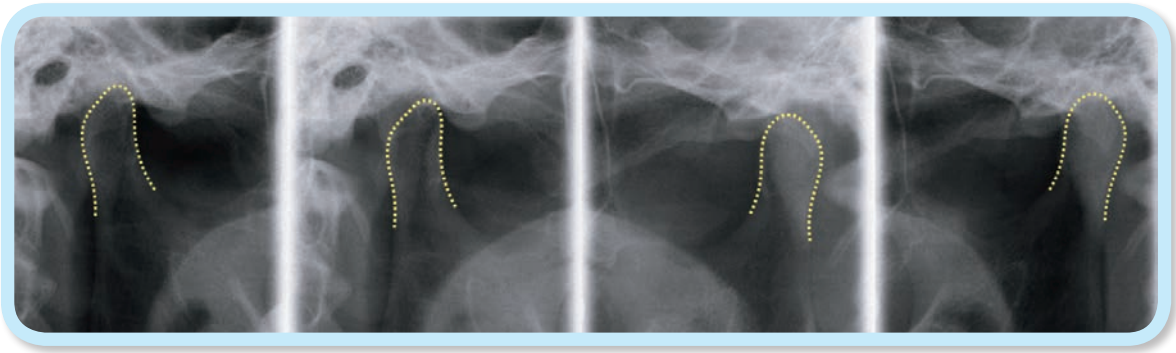


Fig. 7:
Pre-treatment transcranial radiographs show closed and open views for the left and right TMJs on the left and right sides of the figure, respectively.

The etiology of the complex malocclusion was diagnosed as MIH, resulting in unrestorable caries and the extraction of the mandibular permanent 1st molars in childhood, prior to age 10 yrs. Cervical ditching was noted on all lower premolars, consistent with abfraction[10] due to heavy occlusal loading. The American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) was 20 points[11] with 4 points added for a compromised implant site for a total DI of 24 points, as shown in the subsequent worksheet 1.

Treatment Objectives

1. **Cervical Ditching on Lower Premolars**: Align the lower arch to distribute the occlusal load over the entire dentition and emphasize proper brushing technique.

2. **Maxilla and Mandible**: Maintain all skeletal relationships.

3. **Maxillary Dentition**: Increase the axial inclination of the incisors, and flatten the curve of Spee to help correct crowding, overjet and overbite.

4. **Mandibular Dentition**: Close LR6 space, prepare LL6 space for an implant-supported prosthesis (*crown*), increase the axial inclination of the lower incisors, and move the entire lower denture mesially to close space, resolve the overjet, and correct the Class II occlusion.

5. **Facial Esthetics:** Correct the retrusive lower lip.

Treatment Alternatives

Option 1. Extract of the LR8, upright the lower 2nd molars, and restore both missing first molars with fixed prostheses.

Option 2. Nonextraction approach: close the LR space, prepare the LL space for an implant-supported prosthesis, place bite turbos to correct the deepbite, and protract the lower arch with Class II elastics in an L-configuration to correct the overjet.

After considering the pros and cons of each option, the patient preferred Option 2 because it was the most conservative, but she understood it was a very challenging treatment plan that depended on patient compliance to protract the entire lower dentition with Class II elastics. Following preprosthetic alignment and implant placement, the fixed appliances would be used to retain the space and finish the occlusion during the healing period. Remove the fixed appliances when the implant-supported prosthesis is delivered. Retain both arches with clear overlay retainers worn full-time for 6 months and then nights only.

Treatment Progress

A full-fixed 0.022-in slot Damon Q® bracket system (*Ormco, Glendora, CA*) was selected along with the archwires and accessories specified by the manufacturer. High torque was selected for maxillary brackets (*U1 22˚, U2 13˚, U3 11˚*), and standard torque for mandibular brackets (*L1 -3˚, L2 -3˚, L3 7˚*). Brackets were bonded on both arches at the start of treatment (*Fig. 8*), but the flexible archwire 0.014-in copper-nickel-titanium (*CuNiTi*) was not engaged in the lower molars because it was likely to be displaced by masticatory function.

In the 4th month, the bracket was bonded on the LR8, the mandibular archwire was changed to 0.014x0.025-in CuNiTi and all brackets were engaged on the archwire. An open coil spring with light force was used on the LL side to help upright the second molar and increase the space for an implant. On the LR side, the molars were uprighted by the force of the archwire (*Fig. 9*). Anterior bite turbos (*BTs*) were applied on the palatal surfaces of the maxillary central incisors to create inter-maxillary space to help upright the mandibular molars, and intrude the central incisors to correct the 4mm overbite. Light Class II elastics (*Parrot 5/16-in, 2-oz*) were used from the upper canines to lower 2nd premolars bilaterally to begin correction of the sagittal discrepancy.

Fig. 8:
In the 1st month of the treatment (1M), the 0.014-in CuNiTi archwire was used to engage all of the maxillary teeth, but a similar archwire is cut-off distal to the 5s, and the end of the wire is encased in polymerized resin (blue arrows) for patient comfort.

Fig. 9:
In the 4th month (4M), the mandibular archwire was changed to 0.014x0.025-in CuNiTi that was extended into the L7 tubes to deliver an uprighting moment that did not extrude the teeth. An open coil spring (blue arrow) with light force (~10cN) was used on the LL side to open space as the second molar was uprighted. See text for details regarding these non-extrusive mechanics.

In the 8th month, the maxillary archwire was changed to 0.017x0.025-in titanium-molybdenum-alloy (*TMA*) and the mandibular archwire was fitted 0.016x0.025-in SS. An open coil spring was still used on the LL side to retain the space opening. The LR molars were sufficiently uprighted to apply power chains to close the space. Modified L-type Class II elastics (*Fox 1/4-in, 3.5-oz*) were applied bilaterally from the upper canines to the lower 2nd premolar and extended to the 2nd molar. This configuration was designed to protract the lower dentition with minimal bite opening (*Fig. 10*). The LL implant site 8.5mm in length, which was 1mm more than deemed ideal.

In the 10th month, the lower midline had shifted about 2mm to the right, so the L-type Class II elastics (*Fox 1/4-in, 3.5-oz*) were used only on the right side until the asymmetry was corrected. Once the midlines were coincident, the L-type Class II elastics were again used bilaterally.

After 17 months of active treatment, the preprosthetic alignment was complete for the LL implant, and all other spaces were closed. Fig. 11 shows the progressive photographs of the implant site preparation. The midline and overjet were corrected as documented in Fig. 12.

Fig. 10:
In the 8th month (8M), the archwires were 0.017x0.025-in TMA in the maxillary arch and 0.016x0.025-in SS in the mandibular arch. An open coil spring was used on the LL side to retain the space (blue arrow). The LR molars were sufficiently uprighted to apply power chains to close the space. Modified L-type (configuration) Class II elastics (green lines) were applied bilaterally to simultaneously resolve the sagittal discrepancy, assist LR space closure, reduce the missing LL 1st molar space, and control bite opening. See text for details.

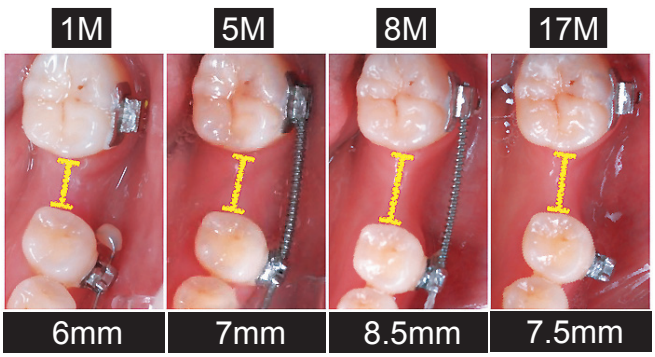


Fig. 11:
Progressive photographs for the first 17 months of LL implant site preparation show that the previously insufficient space (6mm) was increased to an excessive space (8.5mm) with the open coil spring as the LL 2nd molar was uprighted with a moment delivered with the archwire. The distance was gradually reduced to an ideal 7.5mm arch length by sliding mechanics on the 0.016x0.025-in SS wire with power chains and the Class II L-type elastics.

Fig. 12:
Before treatment (0M) the lower midline discrepancy was 1mm to the right which was stable during the first month of treatment (1M). In the 8th month (8M), the midline discrepancy increased to 2-3mm due to the asymmetric mechanics: space closure on the LR and space opening on the LL. The midline discrepancy was corrected by the 17th month (17M) of treatment by using a unilateral L-type Class II elastic on the right side since the 10th month of treatment.

Implant Placement

At 17 months into active treatment, preprosthetic alignment was completed, and a cone-beam computed tomography (*CBCT*) scan were taken. A slice from the center of the implant site was selected and the alveolar bone mass was measured: Height 14.5mm, Width 6.2mm. The anatomical structure of the implant site was studied in multiple slices of the 3D image, and the mental foramen was located (*Fig. 13*). An implant fixture (*Ø4.3x12mm*) from the A+ System®, produced by MegaGen® (*Taiwan*) was chosen. A surgical stent was designed following the 2B-3D rule[12] for precise implant placement to achieve an optimal gingival margin in all three dimensions: mesial-distal (*M-D*), buccal-lingual (*B-L*) and axial.

Under local anesthesia, a #15c scalpel blade was used for a mid-crestal incision. A sulcular incision was performed with a #12 blade from the distal line angle of LL5 to the mesial line angle of LL7 on the buccal surface, and a full thickness soft tissue flap was reflected (*Fig. 14c*). Exposure of the bone revealed an adequate ridge to place a 4.3-mm diameter implant (*Fig. 14d*). A surgical stent was fitted to guide the first lancer drill for the initial osteotomy (*Fig. 14e*), and the guide pin was placed. A periapical film was exposed to check the insertion path and orientation of the osteotomy as revealed by the guide pin (*Figs. 14f and g*).

Following the specifications of the implant manufacturer, the fixture was installed in the center of the ridge according to the 2B-3D rule:[12] 2mm

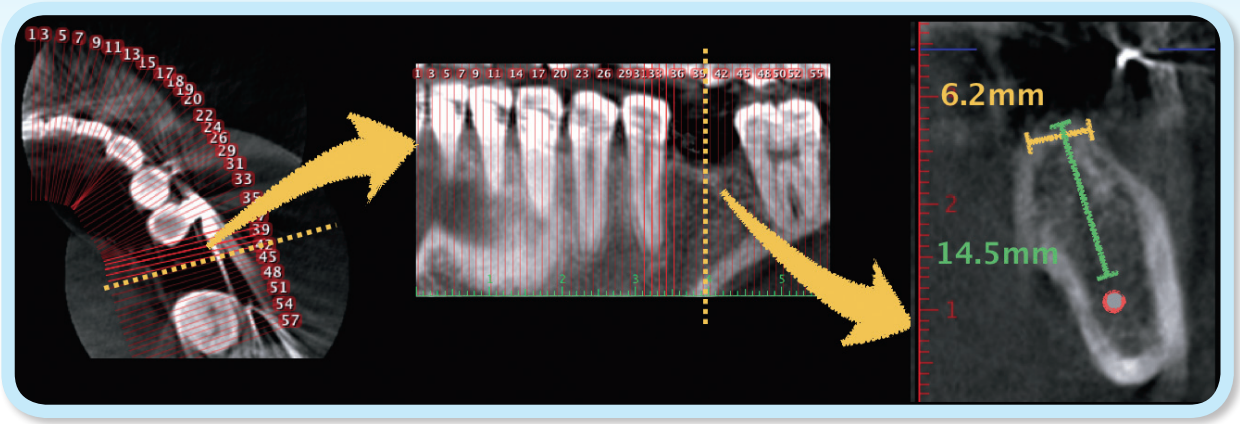


Fig. 13:
A CBCT scan shows the implant preparation in the axial (left), sagittal (middle) and frontal views. The alveolar bone volume height was 14.5mm, and the width was 6.2mm. Anatomic details are noted such as the cortical thickness and trabecular pattern of bone in the site, in addition to the inferior alveolar nerve (red circle) and the mental foramen.

buccal bone thickness and fixture 3mm apical to the expected crown margin (*Figs. 14h and i*). As shown in Figs. 14j and k, the fixture was connected with a healing abutment (*Ø5.0mm x H5.0mm*), and the flap was sutured with interrupted 5-0 GORE-TEX® (*Flagstaff, AZ*) (*Fig. 14l*). After 1 week, the sutures were removed and the prosthesis delivery was planned following a 6-month healing interval.

Orthodontic Finishing Stage

As shown in Figs. 15a and b, the implant fixture was not in the middle of the osseous ridge in the mesial-distal direction. The periapical film showed that the 2nd molar had been tipped mesially, so the distances from the fixture to the premolar and molar were not equal. Flowable resin was added on the mesial side of the activated open coil spring to provide force for uprighting the 2nd molar and increasing the space to the implant (*Fig. 15c*). In the 18th month, 0.016x0.025-in SS archwires were placed on both arches for finishing adjustments.

After 23 months of active treatment, all fixed appliances were removed and clear overlay retainers were delivered. The patient was instructed to wear the retainers full time. Following completion of the final crown for the LL6 implant, a new clear retainer was made.

Implant Prothesis Fabrication

After 6 months of healing, the implant was well integrated, so the healing cap was replaced with a multi-post abutment (*Ø5.0mm, 4.0mm cuff height, and 5.2mm post height*). A torque ratchet was applied at 35 N-cm to seat and secure the abutment in the planned position. Occlusal clearance exceeded 2mm which was deemed adequate to construct a porcelain fused to metal crown (*Figs. 16a-d*).

A coping and post-level analog were chosen to transfer the level of the abutment, and a snap impression was made using polyvinyl siloxane impression material. The impression was poured

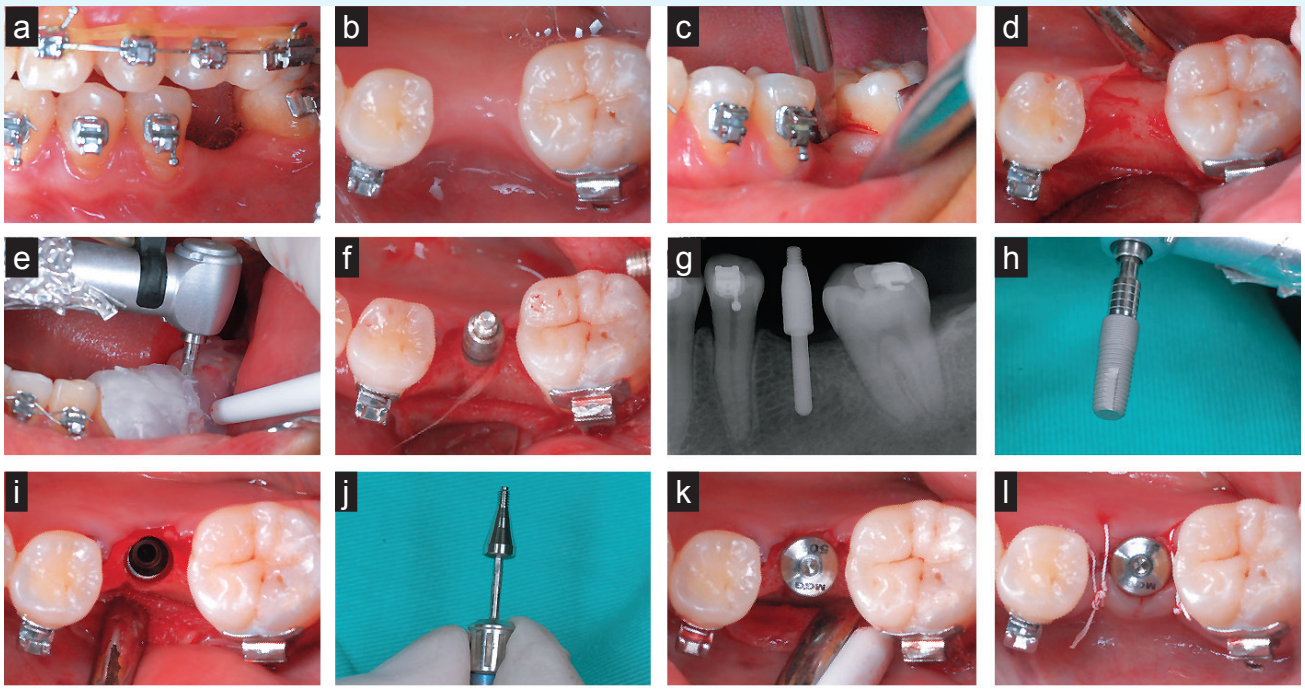


Fig. 14:
Restoration of the LL 1st molar space is illustrated as follows: (a) LL 2nd molar was uprighted and moved mesially to produce a 7.5mm implant space, (b) occlusal view of the prepared implant site, (c) mid-crestal and sulcular incisions were performed for flap reflection, (d) occlusal view of the exposed osseous ridge, (e) a surgical stent was designed for precise implant placement in three dimensions, (f) a guide pin was placed in the osteotomy, (g) a periapical film was taken with the guide pin to check the insertion path and orientation of the osteotomy, (h) a 4.3x12mm implant fixture, (i) occlusal view of the osseous ridge with the implant fixture installed, (j) a 5.0x5.0mm healing abutment (cap), (k) the healing abutment was installed, and (l) the flap was sutured with direct loop interrupted 5-0 GORE-TEX®.

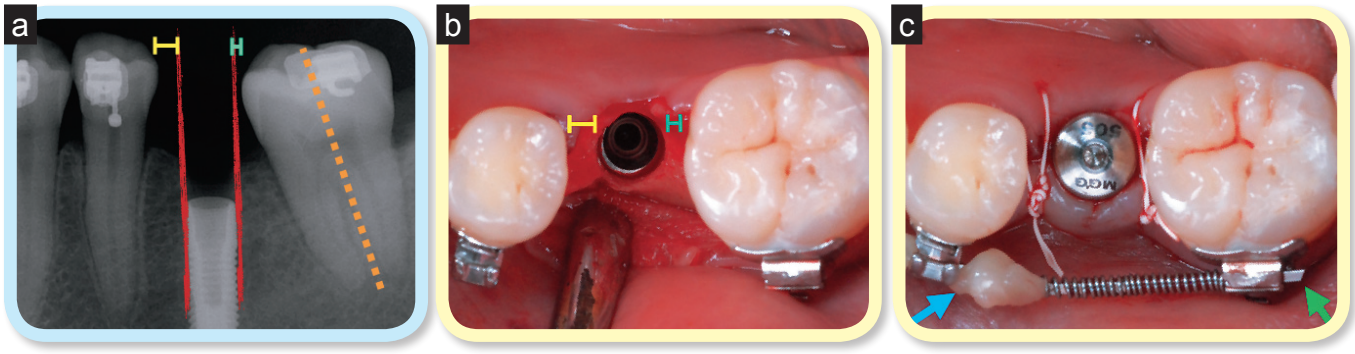


Fig. 15:
(a) A periapical radiograph showed that the 2nd molar was tilted mesially, so the distances from the fixture to premolar and molar were not equal (yellow compared to green lines), (b) An occlusal radiograph documented that the implant was not in the center of the osseous ridge in mesial-distal direction (yellow compared to green lines). (c) Flowable resin was added on the mesial side of the compressed open coil spring (blue arrow) to provide force to upright the 2nd molar. Note that the end of the archwire was extended distal to the molar tube (green arrow) to avoid being disengaged as the molar moved distally.

with Type IV dental stone to prepare a working cast (*Figs. 16e-h*).

When the final prosthesis was seated, appropriate tightness of the contact area was confirmed with dental floss. The occlusal area was made of porcelain because of the patient's esthetic concerns (*Figs. 16i and j*). After clinical adjustment and verification of the fit and occlusion, the permanent crown was completed and retained with temporary cement. After the screw access hole was filled with composite resin, the final prosthesis is shown in Figs. 16k and l. A new clear mandibular overlay retainer was made after completion of the implant-supported crown. The patient was instructed to wear the retainers full time for the first 6 months and nights only thereafter. Home care and retainer maintenance instructions were provided.

Treatment Results

Protraction of the lower dentition, relative to the apical base of bone, produced increased lower lip protrusion, resulting in a more balanced lower facial profile. Intermaxillary alignment was excellent (*Figs. 17 and 18*), as reflected in the Cast-Radiograph

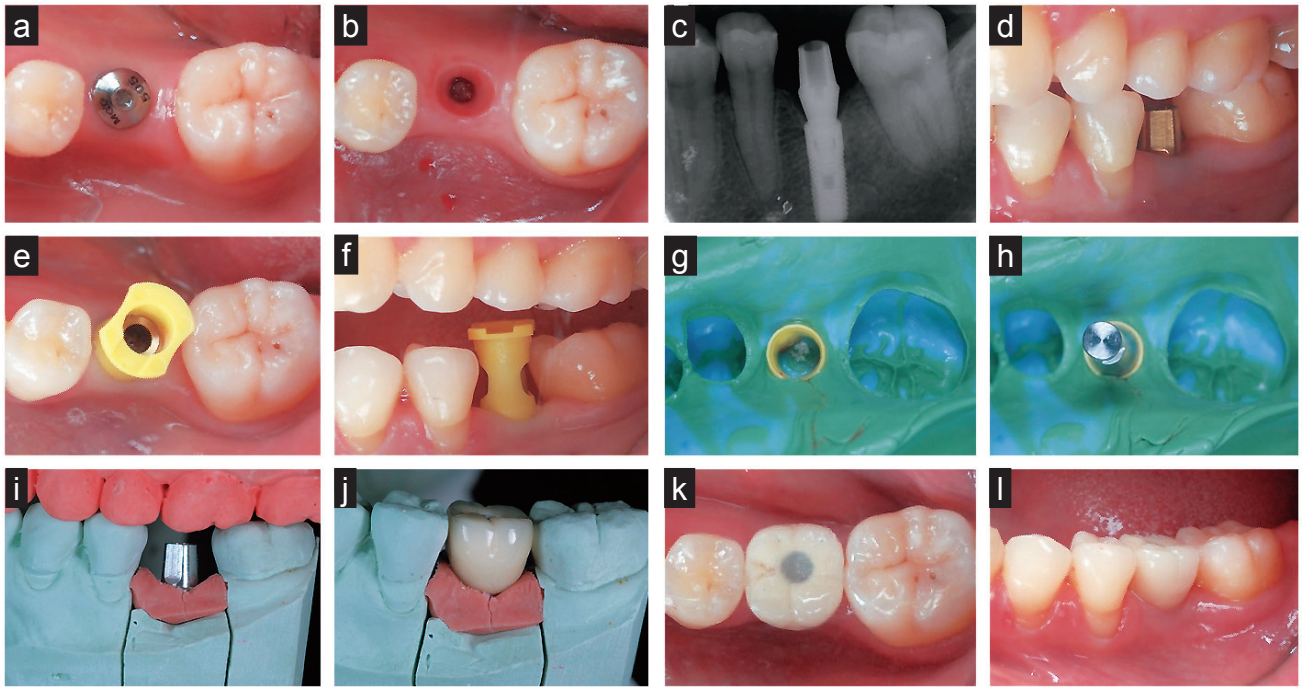


Fig. 16:
The prosthesis fabrication procedure is illustrated: (a) Healing abutment in place. (b) After abutment removal, the soft tissue sulcus is seen along with minimal bleeding points in the non-keratinized buccal mucosa. (d) From the buccal 2mm of inter-occlusal clearance is noted as required for a porcelain fused to metal crown. (e) A "snap" impression coping is inserted into the soft tissue sulcus. (f) From the buccal view the snap coping is securely seated. (g) A pick-up impression with polyvinyl siloxane shows the yellow outline of the impression coping. (h) The corresponding implant analog was "snapped" into the coping embedded in the impression. (i) The impression was poured in type IV dental stone to prepare a working cast. (j) The final prosthesis was fabricated and fitted on the working cast. (k) The occlusal view of the crown is luted with temporary cement. (l) The permanent crown is viewed from the buccal aspect.

Fig. 17: Post-treatment facial and intraoral photographs

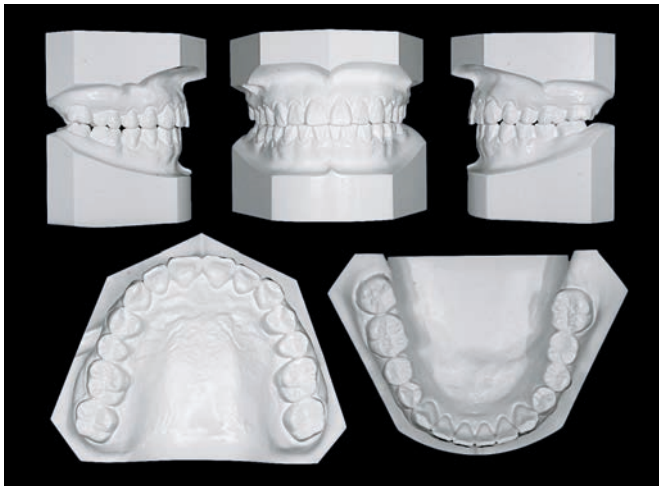


Fig. 18: Post-treatment dental models (casts)

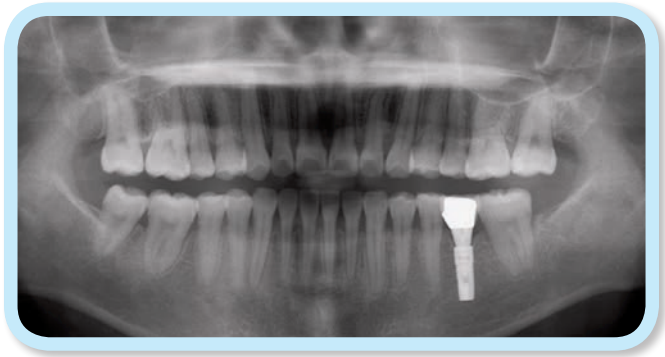


Fig. 19: Post-treatment panoramic radiograph

Evaluation (*CRE*)[13] score of 19 (*Worksheet 2 attached at the end of the report*). The most significant discrepancy was slight overjet in the incisal region (*4 points*). Dental midlines and axial inclinations of the dentition as well as the implant-supported prosthesis were near ideal (*Figs. 17-20*).

The post-treatment cephalometric film (*Fig. 20*) and superimposed tracings (*Fig. 21*) showed that the retrusive lower lip was improved, resulting in a more balanced facial profile. The sagittal inclination of the maxillary incisors was increased 5° to accommodate the desired protraction of the mandibular dentition. At the finish, the axial inclinations of the incisors were decreased for the upper and increased for the lower, consistent with correction of Class II malocclusion in an adult (*Table 1*). However, the dentofacial result was a remarkable improvement for a Class II patient presenting with missing lower first molars bilaterally (*Fig. 21*). The post-treatment TMJ

Fig. 20: Post-treatment lateral cephalometric radiograph

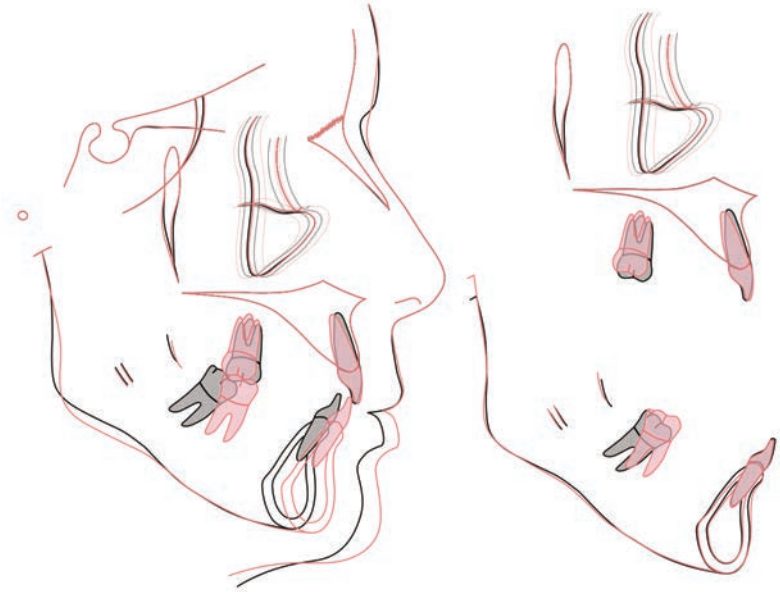


Fig. 21:
Superimposed cephalometric tracings showing dentofacial changes over 23 months of treatment (red) compared to the pre-treatment position (black). The retrusive lower lip was corrected, resulting in a more balanced facial profile. The axial inclination was increased for both the maxillary and mandibular incisors. The maxillary molars were slightly retracted while the LL 2nd molar was protracted to substitute for the missing 1st molar. See text for details.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	85°	85°	0°
SNB° (80°)	78°	81°	3°
ANB° (2°)	7°	4°	3°
SN-MP° (32°)	38°	35°	3°
FMA° (25°)	31°	28°	3°
DENTAL ANALYSIS			
U1 TO NA mm *(4 mm)*	0 mm	-1 mm	1 mm
U1 TO SN° (104°)	95°	100°	5°
L1 TO NB mm *(4 mm)*	5 mm	4 mm	1 mm
L1 TO MP° (90°)	92°	92°	0°
FACIAL ANALYSIS			
E-LINE UL *(2-3 mm)*	-1 mm	-3 mm	2 mm
E-LINE LL *(1-2 mm)*	-2 mm	-1 mm	1 mm
Convexity: G-Sn-Pg' *(13°)*	14°	9°	5°
%FH: Na-ANS-Gn *(53%)*	56.4%	57.2%	0.8%

■ Table 1: Cephalometric summary

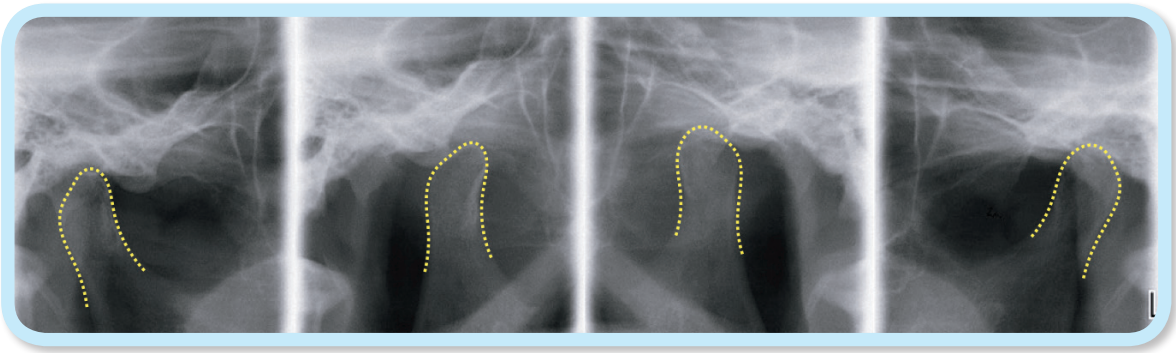
radiographs documented that both condylar heads were well positioned in the fossa and symmetrical with the mandible opened and closed (*Fig. 22*). Following cosmetic gingival contouring,[14] the Pink and White dental esthetic score was 3 points, as documented in Worksheet 3 at the end of this report.

Overall, the conservative approach for managing this challenging malocclusion was quite successful. Defining the etiology of the skeletal malocclusion as a functional retrusion due to MIH as a child increased the confidence that this conservative approach was appropriate. She was well satisfied with both the improved esthetics and function.

Discussion

Uprighting lower second molars

A mesially tipped molar is usually uprighted by tipping the crown distally.[9] However, a *"false"* extrusion/eruption can occur with the crown tipping due to pure rotation at the center of resistance (C_R).[8] The occlusal surface of the tipped tooth is



■ *Fig. 22:*
Post-treatment TMJ radiographs show that mandibular contours and articular relationships are WNL for both on the right and left sides. The open and closed positions for the right TMJ are shown in the two images on the left side, and the same relationships for the left TMJ are shown on the right side of the illustration.

aligned along the occlusal plane without extruding relative to the apical base of bone (*Fig. 23*). The latter uprighting method is a reversal of the etiology by which the second molar tipped into the missing first molar space. Since non-intrusive mechanics were used to upright the second molars,[8] anterior BTs were indicated to intrude the incisors (*Fig. 24*), for correction of the anterior overbite, without opening the lower facial height (*Fig. 21*). The L-configuration of the Class II elastics also helped control the vertical dimension of occlusion (*VDO*) because of the vertical component of force from the maxillary canines to the lower second premolars (*Fig. 10*).

There were three keys to uprighting the tipped mandibular second molars without extrusion (*Fig. 25*):

(1) Full fixed appliance with an 0.014x0.025-in CuNiTi archwire that extends through the tubes on the lower second molars.

(2) Molar tubes were placed with a more gingival orientation on the mesial aspect of the bracket to intensify the root uprighting moment,[15] resulting in equal and opposite moments on the second molars and the anterior segment of the dentition.

(3) The force on the open coil spring was very low to avoid overpowering the moment provided by the archwire.[16,17] If the force from the coil spring is too great, the molar will be uprighted primarily by the moment of the force, which results in a

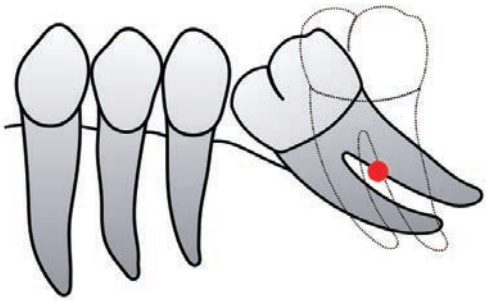


Fig. 23:
Rotation of the tooth around the C_R is anticipated from the application of a moment, when there is little no distal force applied. Although the molar is not actually extruded, the uprighting may cause occlusal prematurities as the axial inclination of the molar is corrected. The problem can be corrected with occlusal adjustment of the molar or leveling the occlusal plane of the entire buccal segment.

Fig. 24:
Anterior BTs (red arrow) were used to create intermaxillary clearance to upright the tipped molars and align the lower buccal segments. The mechanics were used with Class II elastics in an L-configuration to help control bite opening as the lower curve of Spee was corrected. See Fig. 10.

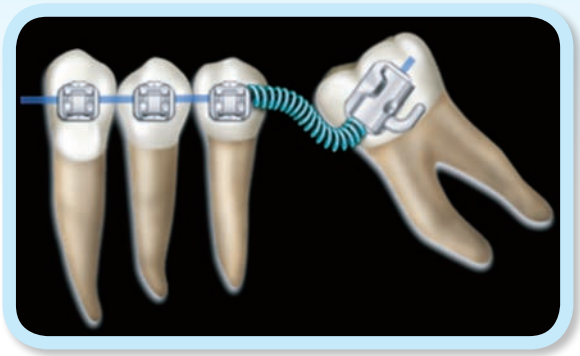


Fig. 25:
Mechanics to upright the second molars with rotation near the C_R and minimal extrusion to open the bite were: (1) highly flexible 0.014-in CuNiTi archwire, (2) open coil spring with very light force, and (3) bonding the bracket with a mesial rotation to position the anterior portion of the bracket closer to the gingiva. See text for details.

center of rotation (*C*) that is apical to the C_R and the molar will extrude,[18,19] due to the inclined plane effect of the root engaging the tapered alveolus.[20]

No open coil spring was used on the LR side because the LR 1st molar space was to be closed. The advantages of these 3 keys are that they contain no auxiliaries, such as push springs, T-loops, and hooks; therefore, patients can be treated with a simple routine orthodontic treatment.

Rate Of Mesial Translation Of Mandibular Molars

Treatment time is an important consideration in planning the mesial translation of mandibular molars into missing L6 sites with a probable MIH etiology. Roberts, Arbuckle and Analoui[18] described the bone physiology of 2nd and 3rd mandibular molar protraction into a missing 1st molar space. The relatively flat roots of the molars move through the center of the alveolar process by resorbing primarily trabecular bone on the mesial surface and forming cortical bone on the distal surface of each root. For the first few millimeters of tooth movement, the molars move rapidly, but when the trailing root engages the cortical bone formed by the leading root, the rate of molar protraction decreases.[18] Ricketts et al.[21] proposed that cortical bone is more resistant to resorption than trabecular bone because of a lack of internal vascularized spaces.

Roberts, Arbuckle and Analoui[18] reported that: (*1*) sustained orthodontic translation is a physiological manifestation of bone modeling and remodeling throughout the adjacent alveolar process, and (*2*) the rate of mandibular molar translation is inversely related to the apparent radiographic density of the resisting alveolar bone. Theoretically a tooth can move at the linear rate of resorption at the PDL/bone interface,[22] but reactivations, adjustments and engagement of progressive archwires produces repeated areas of PDL necrosis that inhibit the rate of tooth movement and enhance the incidence of root resorption.[19]

Asymmetric Mechanics

Asymmetric space closure and opening mechanics can result in midline changes.[23] The treatment plan for the current patient with an initial midline deviation 1mm to the right (*Fig. 1*) was to close the 1st molar space on the LR side, and increase the space on the LL side to produce a site for an implant-supported crown. The net effect for these asymmetric mechanics was to increase the deviation

of the lower midline to the right. This problem was successfully managed with asymmetric Class II elastics; only the left Class II elastic was worn until the midline were coincident. Then bilateral Class II L-configuration elastics were used to complete the intermaxillary correction (*Fig. 17*). This approach required excellent patient compliance which was discussed at the pretreatment consultation. It is important to inform the patient that TADs and/or asymmetric interproximal enamel reduction (*IPR*) may be required if the deviation is greater than expected or compliance is inadequate. IPR is a particularly effective alternative if there are black interdental spaces and/or a tooth size discrepancy.[24]

Orthopedic Correction

Treatment time for conservative correction of acquired skeletal Class II malocclusion with a probable MIH etiology depends on the rate of tooth movement,[18] management of the symmetry if needed (*Fig. 12*), and orthopedic correction (*Fig. 21*). The rate of tooth movement is the limiting factor for aligning or restoring the missing L6 spaces.[18] Continuous mechanics with low PDL stress[24] is the goal for uprighting the mesially tipped L7s with CuNiTi archwires and mesially rotated brackets (*Fig. 25*). Orthopedic correction of the skeletal discrepancy due to an apparent functional retrusion can be

Fig. 26: Two-year post-retention facial and intraoral photographs

accomplished in adults with functional orthopedics[25] or a spontaneous correction with bite turbos and Class II elastics (*Figs. 10, 21 and 24*). The critical factors for achieving orthopedic correction in adults are correction of the inhibition(s) followed by mechanics to encourage a more anterior posturing of the mandible. Long-term follow-up of Class II division 1 malocclusion in adults treated with functional orthopedics shows that little of the orthopedic effect is retained but the Class I correction is stable.[26] On the other hand, spontaneous orthopedic correction from functional retrusion with bite turbos and L-type Class II elastics appears to be quite stable (*Figs. 26-29*). Additional studies on the long-term follow-up are needed to confirm this promising approach.

2 years follow-up

Two years after treatment was completed, the patient was asked to return for a follow-up evaluation. The treatment results were stable and the occlusion had improved with better occlusal contacts in the buccal segments (*Fig. 26*). The post-retention panoramic radiograph shows good osseous health for the mesially protracted LR 2nd and 3rd molars, as well as for the implant-supported prosthesis (*Fig. 27*). The lateral cephalometric radiograph and superimposed tracings document a stable mesial movement of the lower dentition relative to the basilar mandible. It was particularly gratifying to note that the residual overjet of the incisors was resolved (*Figs. 28 and 29*). The post-retention TMJ images show the length, size and position of the condylar heads were maintained, and there were no signs or symptoms of temporomandibular disorder (*Fig. 30*).

Conclusions

(1) MIH-related loss of mandibular first molars is a common etiology for an acquired Class II malocclusion, either unilateral of bilateral. Early loss of both mandibular first molars often produces a distinctive acquired malocclusion: mesially tipped second molars, deep curve of Spee, mandibular retrusion, decreased axial inclination of maxillary incisors, with deep-bite and/or increased overjet.

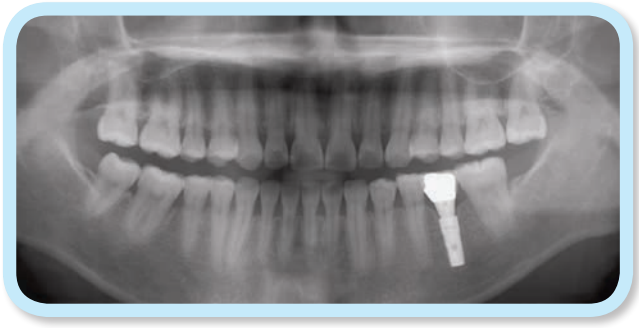


Fig. 27: Two-year post-retention panoramic radiograph

Fig. 28: Two-year post-retention lateral cephalometric radiograph

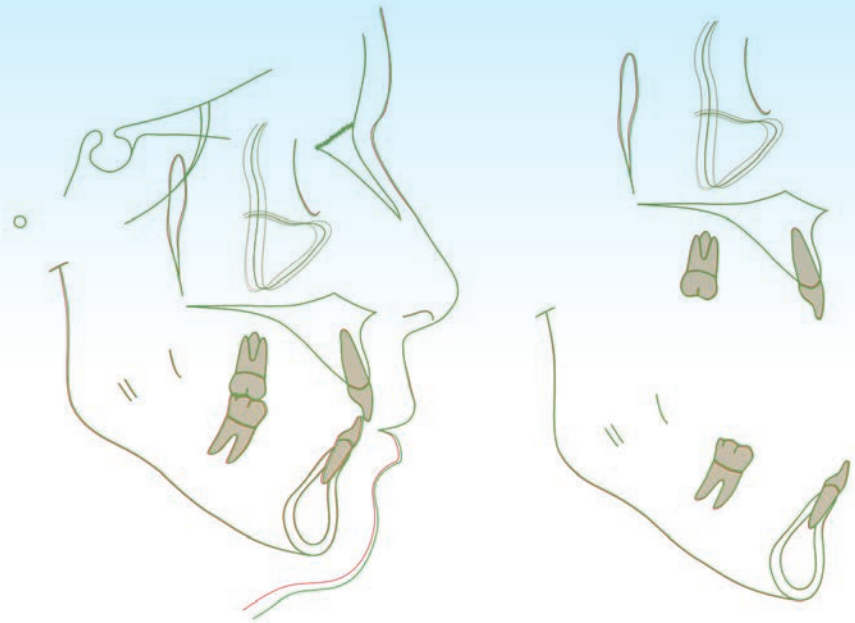


Fig. 29:
Superimposed cephalometric tracings show two-year post-retention dentofacial changes (green) compared to the post-treatment position (red). The mandible moved forward to improve the occlusal relationship, and the immediate post-treatment 1mm of overjet was corrected.

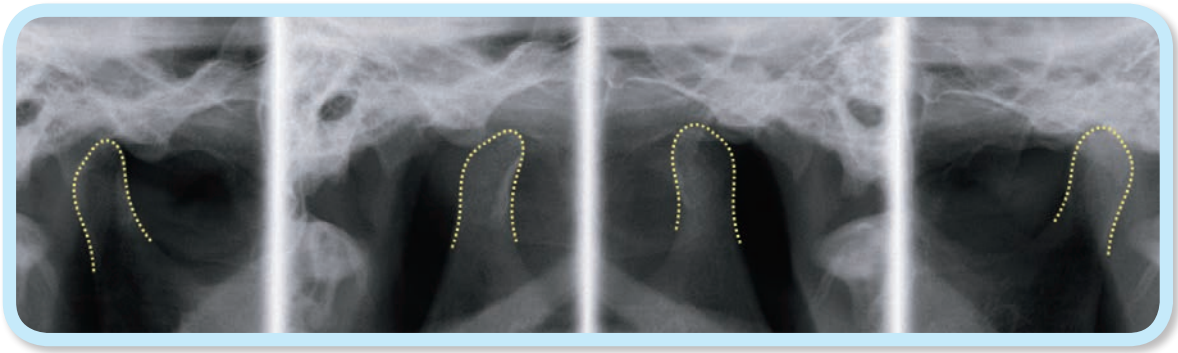


Fig. 30:
Two-year post-retention TMJ radiographs show form and function is WNL. The right TMJ is shown in the left two images, and the left TMJ is shown in the right two images. The two center images are with the mandible opened, while the far left and far right images are with the mandible closed.

(2) If the lower 3rd molar is present, space closure is usually the best option, but when it is absent, space opening and an implant-supported crown is preferable.

(3) Defining the etiology of an acquired malocclusion is important for understanding the potential for a functionally retruded mandible to readapt (*"grow"*) into a more anterior position. MIH-related Class II malocclusions can usually be managed with conservative mechanics designed to upright second molars, remove functional interference with bite turbos, and protract the mandibular dentition without opening the bite (*VDO*).

(4) Midline discrepancies are controlled with unilateral intermaxillary elastics in an L-configuration.

Acknowledgment

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 24

OVERJET

0 mm. (edge-to-edge)	=	
1 – 3 mm.	=	0 pts.
3.1 – 5 mm.	=	2 pts. 4mm
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. 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 = 2

4mm (upper)

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 = 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 = 2

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)	2	x 1 pts. =	2
Missing teeth, congenital	_____	x 2 pts. =	_____
Spacing (4 or more, per arch)	1	x 2 pts. =	2
Spacing (Mx cent. diastema ≥ 2mm)		@ 2 pts. =	_____
Tooth transposition	_____	x 2 pts. =	_____
Skeletal asymmetry (nonsurgical tx)		@ 3 pts. =	_____
Addl. treatment complexities	2	x 2 pts. =	4

Identify: Molar protraction x2 (right 2nd & 3rd molars)

Total = 8

IMPLANT SITE

Lip line : Low (0 pt), Medium (1 pt), High (2 pts) =_

Gingival biotype : Low-scalloped, thick (0 pt), Medium-scalloped, medium-thick (1 pt) High-scalloped, thin (2 pts) =_2

Shape of tooth crowns : Rectangular (0 pt), Triangular (2 pts) =_

Bone level at adjacent teeth : ≤ 5 mm to contact point (0 pt), 5.5 to 6.5 mm to contact point (1 pt), ≥ 7mm to contact point (2 pts) =_

Bone anatomy of alveolar crest : H&V sufficient (0 pt), Deficient H, allow simultaneous augment (1 pt), Deficient H, require prior grafting (2 pts), Deficient V or Both H&V (3 pts) =_

Soft tissue anatomy : Intact (0 pt), Defective (2 pts) =_2

Infection at implant site : None (0 pt), Chronic (1 pt), Acute(2 pts) =_

Total = 4

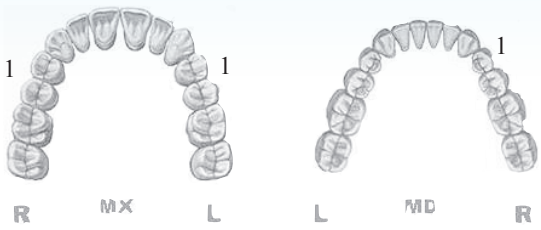
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 19

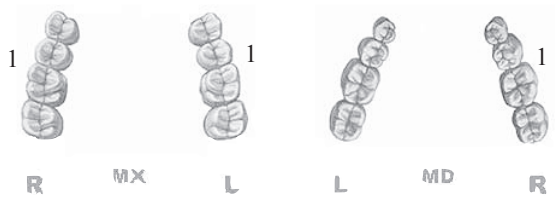
Alignment/Rotations

3



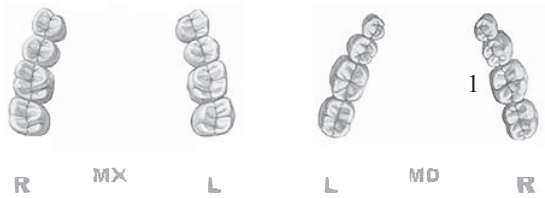
Marginal Ridges

3



Buccolingual Inclination

1

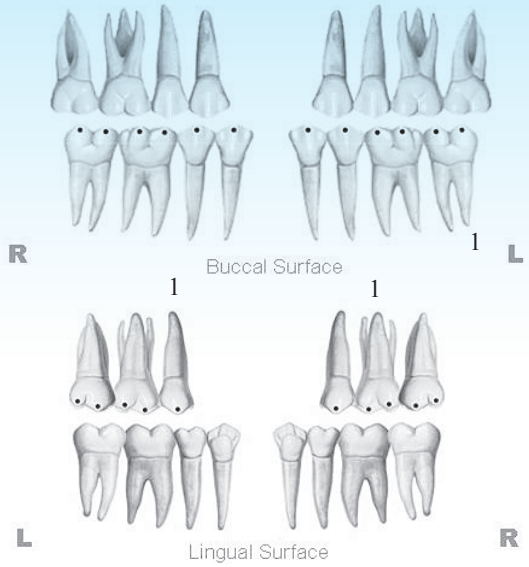


Overjet

4

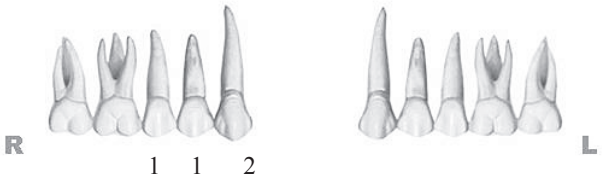
Occlusal Contacts

3



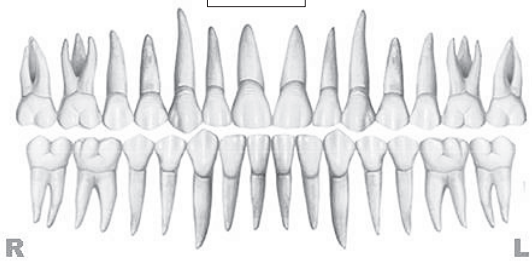
Occlusal Relationships

4



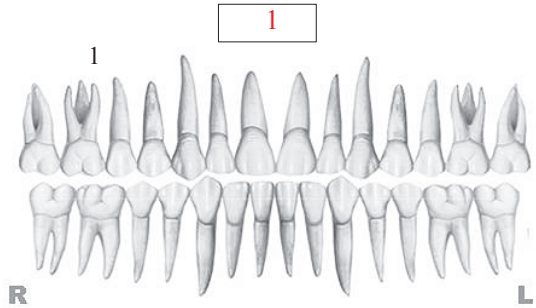
Interproximal Contacts

0



Root Angulation

1



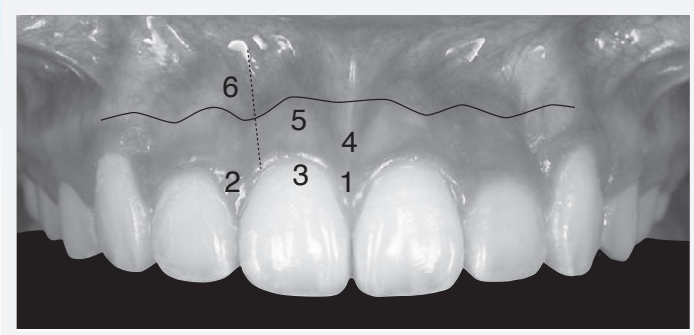
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 3

1. Pink Esthetic Score

Total = 1

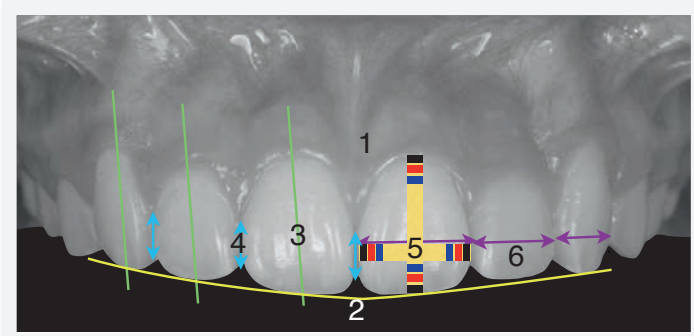


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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

2. White Esthetic Score (for Micro-esthetics)

Total = 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

Dr. Diego Peydro

12 / 07 (Thu)

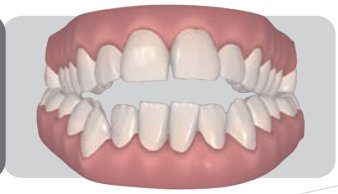
Location: Newton's A

(2F, No. 25, Jianzhong 1st Rd., East Dist., Hsinchu City, Taiwan)

Modern Orthodontics with Clear Aligners Therapy

Successful Strategies to Solve the Most Difficult Cases with Invisalign Technique

Dr. Peydro Diego received his degree in Dentistry from the University of Valencia, Spain in 2000. He was qualified as an Orthodontists from the Southern Mississippi University Institution, Madrid, Spain in 2004. He has been an Associate Professor of the Master in Orthodontics course at the European University of Madrid and Master Collaborator Professor of Orthodontics at the University of Valencia, Spain. Dr. Peydro is the co-director of two continuing training programs focusing on the Invisalign system and teaches globally on Invisalign. He maintains a private practice in Valencia, Spain and is considered one of the leading Invisalign specialists in Europe.



Registration

By 2017/11/01 USD 250 After 11/01 USD 300

Payment: wire transfer (no credit card)

Beneficiary Bank	JIH SUN INTERNATIONAL BANK (SWIFT CODE : JSIBTWTP)
Beneficiary Bank Address	NO.10, SEC. 1, CHONGQING S. RD., TAIPEI CITY, TAIWAN R.O.C.
Beneficiary Name	IAOI
Beneficiary A/C NO.	326-2737621-00

Cancellation policy:
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iAOI

International Association for Orthodontists & Implantologists

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International Association of Orthodontists and Implantologists (iAOI) is the world's first professional association dedicated specifically for orthodontists and implantologists. The Association aims to promote the collaboration between these two specialties and encourage the combined treatment of orthodontic and implant therapy in order to provide better care for our patients.

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Dr. 林詩詠 Joshua Lin

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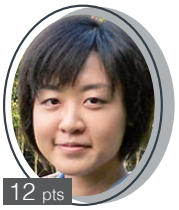
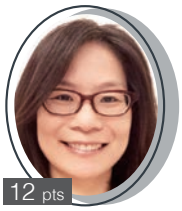


6 case reports

Dr. 曾淑萍 Shu-Ping Tseng



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One who has published 9+ case reports in IJOI.

▲ *Case report(s) published at least once in AJODO.*

● *AJODO/Research paper - 3 points.*
ABO case report - 2 points
Clinical Tip - 1 point

Skeletal Class III Crowded Malocclusion Treated with the Insignia® Custom Bracket System

Abstract

***Chief Complaint (CC)**: A 18-year-old female presented with a CC of poor personal confidence due to an unesthetic smile.*

***Diagnosis and Etiology**: Facial form was concave (G-SN-Pg' -3º) with decreased, but acceptable lip protrusion (E-Line -2/-1mm). An intermaxillary discrepancy of ANB -2º was the sum of slight maxillary deficiency (SNA 81º) and modest mandibular protrusion (SNB 83º). The maxillary arch was asymmetric: (1). Class I on the right, (2). 4mm Class III on the left, (3). 3mm anterior crossbite, and (4). 2mm upper midline deficiency to the right. Both arches were functionally underdeveloped which was manifest as severe dental crowding of -10mm/-6mm in the upper and lower arches, respectively. The intermaxillary arch length deficiency resulted in mesial-out rotation of the lower canines, and the upper canines were blocked out to the labial.*

***Treatment**: The Insignia® system was utilized to digitally plan an ideal intermaxillary alignment, following extraction of all four 1st premolars, that was based on the 3D image of each tooth. The digital set-up was then reverse engineered to construct a full fixed, self-ligating appliance with a custom bracket for each tooth, that produced ideal alignment once the full size archwires were placed. Each tooth was bonded with a custom jig designed for ideal positioning of the bracket on each tooth. This digital method is designed to eliminate repositioning of brackets and archwire adjustments. Comprehensive treatment with progressive stock and custom archwires was accomplished with 10 appointments in 15 months. One finishing bend was required during the detailing phase because of a preventable error during the pre-treatment digital set-up.*

***Outcomes**: The excellent alignment, comfortable occlusion, and pleasing smile substantially increased the patient's poise and personal confidence. This skeletal Class III malocclusion, with a Discrepancy Index (DI) of 28, was treated in 15 months to a Cast-Radiograph Evaluation (CRE) of 16 and a Pink & White Esthetic Score of 1.*

***Conclusions**: Insignia® is a precise method for a direct path to outstanding clinical outcomes with minimal chair time, adjustments and treatment duration. The rate of tooth movement is enhanced, and the incidence of root resorption is reduced, by controlling PDL stress and repetitive episodes of necrosis via progressive relatively flexible archwires, that require few if any detailing adjustments. (Int J Orthod Implantol 2017;47:52-69)*

Key words:
Insignia® system, digital bracket positioning, passive self-ligating bracket, archwire sequence, custom bracket, custom torque, low periodontal ligament (PDL) stress, necrosis, ectopic eruption, Class III malocclusion, crowding, occlusal bite turbo, dental esthetics

Introduction

The Insignia® System (*Ormco, Glendora, CA*) was introduced in 1987 by Dr. Craig Andreiko, an orthodontist and an on-the-job trained engineer. The clinical method involves two components: (*1*) Insignia Approver®: three-dimensional (*3D*) real-time, virtual treatment planning software, and (*2*) Customized Fixed Appliance: brackets, placement jigs, and archwires. Insignia Approver® provides a digital simulation of the desired result according to clinician's preference. Based on prescribed tooth alignment, the off-site system produces custom brackets and archwires by a reverse engineering process. Bracket-positioning jigs are fabricated

Dr. Angle Lee,
Director, Beethoven Orthodontic Center, Hsinchu, Taiwan
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Dr. Chris Chang,
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Publisher, International Journal of Orthodontics & Implantology (Center)

Dr. W. Eugene Roberts,
Editor-in-chief, International Journal of Orthodontics & Implantology (Right)

Fig. 1: Pre-treatment facial and intraoral photographs

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

Fig. 3: Pre-treatment panoramic radiograph

to assist the clinician in accurately bonding a customized bracket on each tooth. Insignia® produces clinical efficiency by controlling and minimizing variables to achieve optimal results with minimal treatment duration.[1-4] The precisely defined brackets facilitate the initial alignment and leveling to receive a rectangular archwire in each arch. Once full-sized rectangular archwires are placed, each arch becomes a segment that is biomechanically akin to a large multi-rooted tooth.[5] When arches are moved as segments, major corrections are accomplished with determinate mechanics because each segment is a single abutment. The PDL stress of segmental mechanics is inherently low because the applied load is divided over the entire root surface of all teeth in the segment.[5]

Diagnosis and Etiology

A 18-year-8-month female complained about her "*embarrassing smile.*" A concave facial profile (*-3º*) was associated with decreased but acceptable lip protrusion (*E-Line -2mm/-1mm*). The lower facial height was relatively increased (*56.1%*) because of a deficiency in maxillary height. The maxillary midline was shifted 2mm to the right relative to the facial and mandibular midlines. The face was relatively symmetric in the frontal view but dental exposure when smiling was asymmetric (*Fig. 1*).

The intraoral examination and dental casts revealed asymmetric buccal segments: Class I on the right side and 4mm Class III on the left. Bimaxillary crowding (*-10mm/-6mm*) was associated with a 3mm anterior crossbite. Maxillary canines were blocked out to the labial, and mandibular canines were rotated in on the mesial. There were numerous cervical carious lesions (*Figs. 1 and 2*). The panoramic radiograph showed four unerupted (*impacted*) third molars, and symmetric mandibular condyles (*Fig. 3*). No temporomandibular disorder (*TMD*) signs or symptoms were reported or clinically evident. The pre-treatment cephalometric analysis documented a mandibular protrusion (*ANB -2º*) due to a slightly retrusive maxilla (*SNA 81º*), that was also vertically deficient (*~46% of Na-ANS-Me*), and a moderately protrusive mandible (*SNB 83º*). The upper incisors were labially inclined (*U1 to NA 6mm, U1 to SN 114º*), and the axial inclination of the mandibular incisors was decreased (*L1 to NB 2mm, L1 to MP 84º*) (*Table 1 and Fig. 4*). The American Board of Orthodontic (*ABO*) Discrepancy Index (*DI*) was 28 points, which is classified as a severe skeletal malocclusion as documented in the Worksheet 1 at the end of this report.[6]

Fig. 4: Pre-treatment lateral cephalometric radiograph

The etiology of the blocked out upper canines was inadequate development of the maxillary arch to accommodate the adult dentition. This is a common problem in developed countries because children eat prepared food, that does not require sufficient masticatory loading to fully develop jaw width.[7] Since the current skeletal Class III patient maintained lip competence and tongue pressure during the mixed dentition phase, incisor inclination was a typical expression of Class III compensation: labially inclined upper and lingually inclined lower incisors. Furthermore, the maxillary canines were buccally blocked out because they were the last permanent teeth to erupt in an arch, with inadequate space for the dentition. The asymmetric Class III molar relationship probably reflects ectopic eruption of the upper right lateral incisor and premature loss of the right deciduous canine. The upper right first molar then moved mesially into a Class I relationship, despite the prognathic relationship of the mandible as evidenced by the left Class III molar relationship. Overall, the etiology of this severe malocclusion (*DI 28*) was consistent with an extraction treatment plan to restore adequate esthetics and function.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	81°	81°	1°
SNB° (80°)	83°	82°	1°
ANB° (2°)	-2°	-1°	1°
SN-MP° (32°)	33°	35°	2°
FMA° (25≥)	26°	28°	2°
DENTAL ANALYSIS			
U1 To NA mm (*4 mm*)	6 mm	5 mm	1 mm
U1 TO SN° (104°)	114°	110°	4°
L1 To NB mm (*4 mm*)	2 mm	1 mm	1 mm
L1 TO MP° (90°)	84°	80°	4°
FACIAL ANALYSIS			
E-LINE UL (*-1 mm*)	-2 mm	-2 mm	0 mm
E-LINE LL (*0 mm*)	-1 mm	-2 mm	1 mm
Convexity: G-Sn-Pg' (*13°*)	-3°	0°	3°
%FH: Na-ANS-Gn (*53%*)	56.1%	57.3%	1.2%

■ Table 1: Cephalometric summary

Treatment Objectives

(1) Achieve a harmonious facial profile

(2) Restore caries and improve oral hygiene

(3) Correct the anterior crossbite, crowding and midline discrepancy

(4) Achieve ideal Class I dental alignment and intermaxillary occlusion

Treatment Alternatives

The first consideration was orthodontics combined with orthognathic surgery. After relieving the crowding and decompensation of the dentition, the facial balance is restored via a mandibular setback. However, the skeletal discrepancy (*ANB -2*) was not sufficient to require orthognathic surgery, and the patient declined the option.

The second alternative was orthodontic treatment with premolar extractions. Although asymmetric premolar extractions was considered, extraction of both upper first premolars was preferred for rapid resolution of the ectopic canines and correction of the axial inclination of the maxillary incisors.

Appointment	Archwire	Notes
1 (0 months)	U: 0.014-in Damon CuNiTi L: 0.014-in Damon CuNiTi	Unlock the anterior crossbite with posterior bite-turbos constructed with Fuji II Type II Glass Ionomer cement (GC America, Alsip IL) on the occlusal surfaces of the L7s. The UR2 was palatally blocked-in with inadequate space to bond the bracket; an open coil spring was used to create space. A light power chain (2-oz) was applied from the UR3 to the UR6 to retract the canine. Early light short Class III elastics (Quail, 3/16-in, 2-oz) were used from the U5s to L3s, to retract the lower canines and to relieve lower anterior crowding and gingival recession.
2 (4 months)	U: 0.016-in Damon CuNiTi L: 0.018-in Damon CuNiTi	The UR2 bracket was bonded.
3 (6 months)	0.014x0.025-in Insignia CuNiTi	The Class III elastics were moved from U5 to U6 to add more horizontal vector to retract the lower anterior teeth, and correct the anterior crossbite.
4 (8 months)	0.018x0.025-in Insignia CuNiTi	
5 (10 months)	0.021x0.025-in Insignia CuNiTi	The Class III elastics were changed to Fox (1/4-in, 3.5-oz) as the overjet improved (edge to edge).
6 (11 months)	0.019x0.025-in Damon SS	Once the crossbite was solved, power chains were applied to close the extraction spaces on the SS working wire. The Class III elastics were changed to Class II elastics from the U3s to L6s to control lower anterior teeth uprighting during space closure.
7 (12 months)	0.021x0.025-in Insignia CuNiTi	
8 (13 months)	0.021x0.025-in Insignia TMA	
9 (14 months)		The incisal edges of the right central and lateral incisors were not well aligned. A first order bend (in-and-out bend) was applied to correct this discrepancy (Fig. 6).
10 (15 months)		All appliances were removed. Anterior fixed retainers were bonded on all maxillary incisors (2-2), and on all mandibular canines and incisors (3-3). Removable clear overlay retainers were delivered for both arches, and the patient was instructed to wear them full time for the first 6 months and nights only thereafter. Instructions were provided for home hygiene and maintenance of the retainers.

■ Table 2: Treatment Sequence.

However, this approach would require more Class III elastics and may result in less maxillary protrusion. After a discussion of the pros and cons of the alternatives, the patient chose the second option with extraction of all four 4s because it was less invasive than orthognathic surgery, and furthermore she preferred less lip protrusion.

The Insignia System® was selected for custom construction of the fixed appliance with passive self-ligating (*PSL*) brackets (*Damon Q®, Ormco, Glendora CA*). All archwires and orthodontic auxiliaries were produced by the same company, unless otherwise stated.

Digital Set-Up

(1) Vertical Movement:

Upper: *Extrude incisors 1mm,*

Lower: *Intrude incisors 2mm, intrude lower molars 1mm*

(2) Anterior overbite: *1.5mm*

(3) Crown Torque:

Upper: *Decrease 10 degrees*

Lower: *Increase 10 degrees*

*Note: The upper incisor crown torque was uprighted from 114º (*pre-treatment*) to 104º (*standard*). The lower incisor torque was increased from 84º (*pre-treatment*) to 94º (*standard 90º + over-correction 4º*). Early Class III elastics to resolve anterior crossbite and lower anterior crowding, but the elastics were expected to upright the lower anterior segment, so the lower incisors required more positive torque.

(4) Extract upper and lower 4's.

(5) A/P movement and space closure *(Fig. 5)***:**

UR6, LR7, LL7: *Move 2mm mesially*

LL6: *Move 3mm mesially*

Close upper spaces by canine retraction and protrude incisors. Close lower spaces by anterior retraction.

(6) Midline correction *(Fig. 6)***:**

Move upper midline 3mm left to coincide with the lower midline.

(7) Archwire Plane:

Center of upper and lower central incisors.

Treatment Progress

Before bonding the brackets, four first premolars were extracted, and all decay was restored. Figs. 7-11 shows the 13 month sequence of applied mechanics. Fixed appliances were removed two months later (*15 months*).

Treatment Results

After 15 months of active treatment, a harmonious facial profile and a pleasing smile was achieved. The

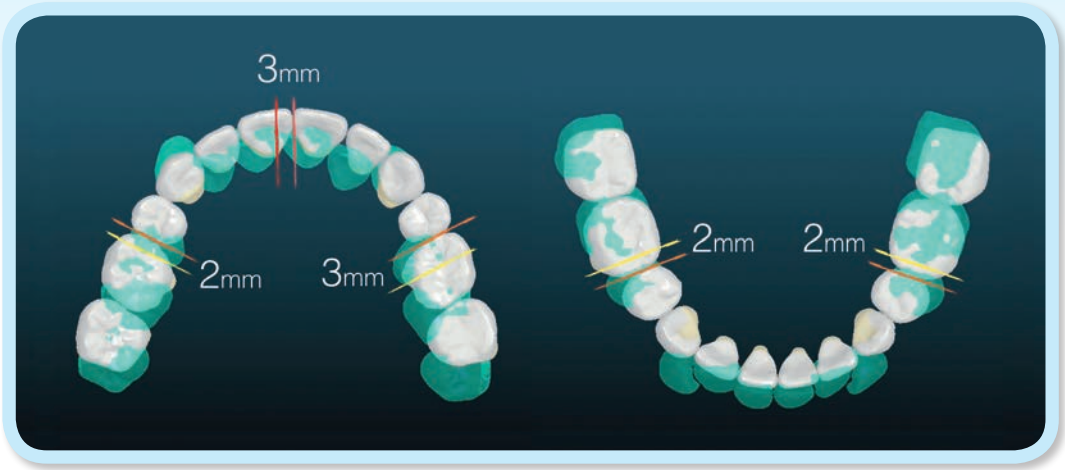

Fig. 5:

Digital set-up prescribes movement in the sagittal plane and space closure. White teeth are the post-treatment dentition. Green teeth are the pre-treatment dentition. Yellow lines mark the pre-treatment mesial surfaces of the first molars. Orange lines are the post-treatment mesial surfaces of the first molars. Red line is the pre-treatment upper midline. Pink line is the post-treatment upper midline.

***Left**: Move tooth UR6 2mm mesially. UL6 is to be moved 3mm mesially. Close upper spaces with canine retraction in conjunction with incisor protrusion. Move the upper midline 3mm to left as shown by the red and pink lines.*

***Right**: Move teeth LL7, and LR7 2mm mesially. Close lower spaces by retracting the mandibular anterior segment.*

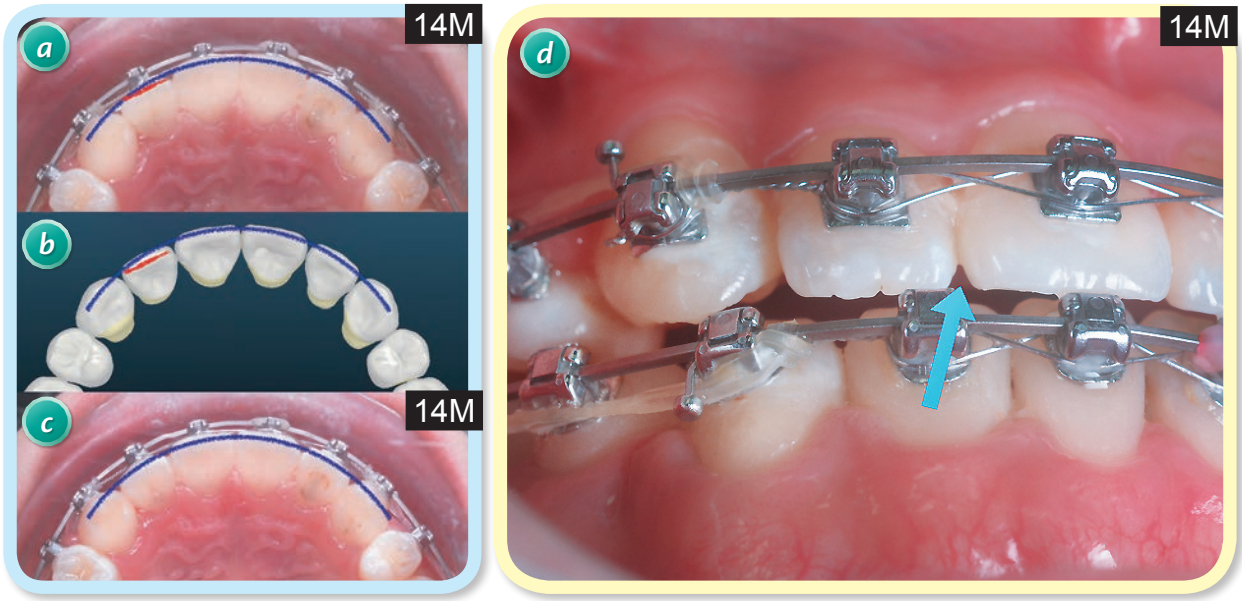

Fig. 6:

A discrepancy between the upper right central and lateral incisors was noted from the occlusal view (a) and frontal view (d) at fourteen months (14M). When comparing the intraoral photograph (a) to the digital set-up (b), the incorrect UR2 alignment (red lines) is almost the same. A first order bend (in-and-out bend) was applied to resolve the discrepancy which was actually an error in the digital alignment. See text for details.

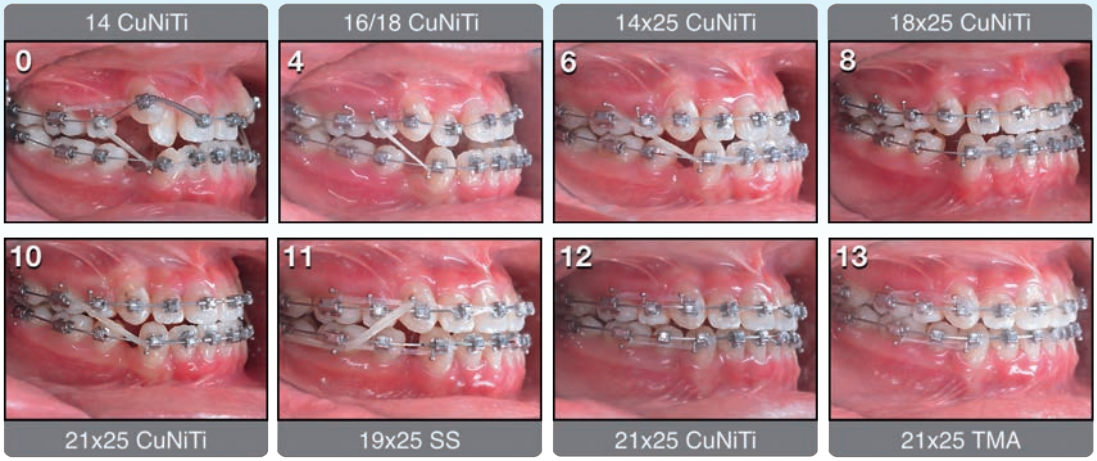

Fig. 7:
The right lateral views for the first 13 months of applied mechanics. The archwire type is shown at the top of each photo, and treatment time in months is an inset number in the upper left corner.

Fig. 8: A series of frontal views is similar to Fig. 7.

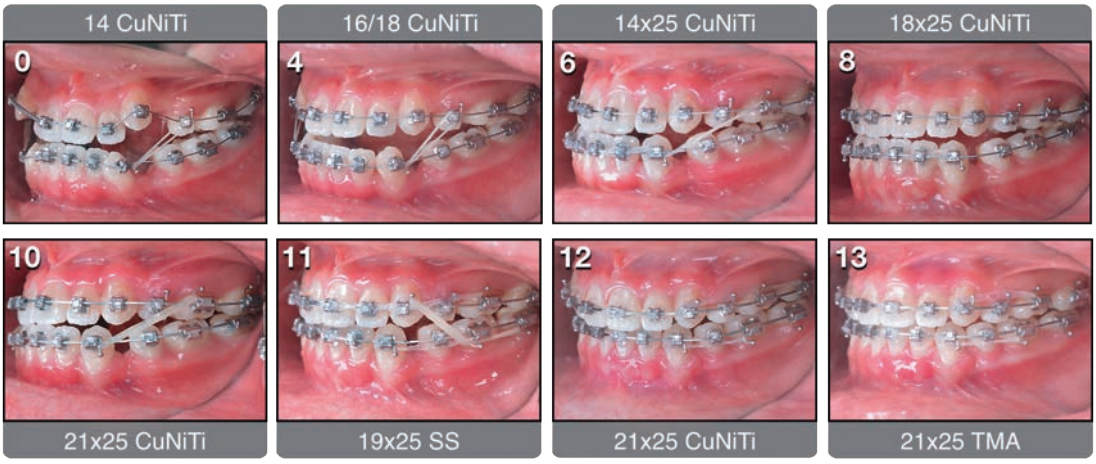

Fig. 9: A series of left lateral views is similar to Fig. 7.

Fig. 10: A series of upper occlusal views is similar to Fig. 7.

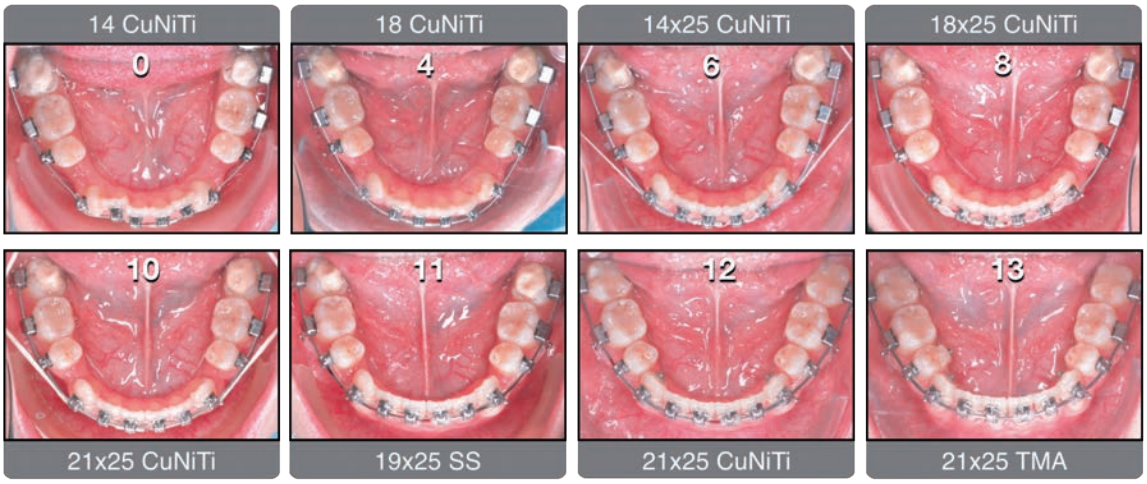

Fig. 11: A series of lower occlusal views is similar to Fig. 7.

anterior crowding and crossbite were resolved, resulting in a near ideal Class I occlusal relationship (*Figs. 12 and 13*). The treatment outcome was an excellent 16 points with the ABO Cast-Radiograph Evaluation (*CRE*), as shown in the supplementary worksheet 2 at the end of this report. The major residual problems were discrepancies in marginal ridges and buccolingual inclinations.[8] The post-treatment cephalometric and panoramic film are shown in Figs. 14 and 15. The condylar head positions were symmetrical; no TMD signs or symptoms were reported before, during or after treatment.

The superimposed tracings and cephalometric analysis (*Fig. 16 & Table 1*) show that the ANB angle increased 1°, due to the retraction of the lower anteriors and clockwise rotation of the mandible. Torque control of the upper incisor was ideal (*U1-SN=110º*), but mandibular incisor torque was decreased after lower extraction spaces were closed (*L1-MP=80º*).

Fig. 12: Post-treatment facial and intraoral photographs

Fig. 13: Post-treatment dental models (casts)

Fig. 14: Post-treatment panoramic radiograph

Fig. 15: Post-treatment lateral cephalometric radiograph

In retrospect, increased torque of the lower incisors was indicated during the treatment planning phase, but that change may have resulted in an end-to-end incisal relationship. Another option was to extract U5s and L4s, but that may have required a bone screw to resolve the asymmetric maxillary segments. Another potential option was an asymmetric extraction pattern: UR4, UL5 and L4s. This approach had esthetics appeal because the UR4 had longer crown length than the UR5, but this problem was subsequently corrected with a diode laser (*Fig. 17*). In any event, a more positive torque value for the lower incisors was indicated during the digital set-up phase to compensate for lingual tipping during space closure.

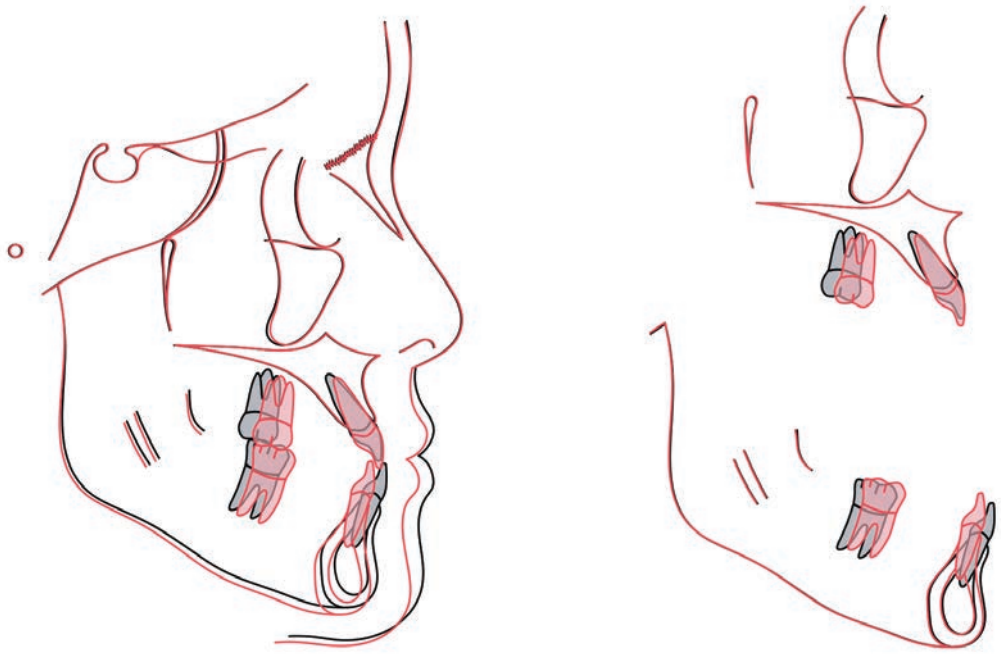

Fig. 16:
Pre-treatment (black) and post-treatment (red) cephalometric tracings are superimposed on the anterior cranial base (left), the maxilla (upper right), and the mandible (lower right). See text for details.

The Pink and White dental esthetic score was 1 point, as shown in the supplementary Worksheet 3 at the end of this report. There was an altered passive eruption around the gingival margin of upper premolars, and the gingiva was re-shaped with a diode laser. After one week, the gingiva has been recovered well (*Fig. 17*).[9] The patient is well satisfied with her functional occlusion, and she feels more confident with her attractive smile (*Fig. 18*).

Fig. 17:
***Upper**: A series of three intraoral photographs shows the gingival margins after fifteen months (15M) of active treatment.*
***Lower**: A similar series of photographs at one-week follow-up (1w-F/u) show the labial gingival margins after the labial surfaces of the U5s were adjusted with a diode laser.*

Fig. 18:
The oblique facial view on the left shows the esthetic and function compromise at the start of treatment (0M). A similar facial photograph on the right shows the pleasing result after fifteen months (15M) of active treatment. The patient is well pleased with her improved facial esthetics and attractive smile.

Discussion

Effectivity and efficiency

A reverse engineered bracket system allows clinicians to provide not only effective but also efficient treatment with decreased treatment time and fewer appointments.[2,3] In 1976, The original straight-wire appliance featured first, second, and third order prescriptions for each tooth; this improved the efficiency and consistency of the treatment results because less wire bending was required.[10] A critical element in the success of any straight wire appliance is accurate positioning of brackets on every tooth to precisely express the prescribed rotation, tipping, and torque values. However, it is clinically difficult to accurately position brackets visually, so considerable bracket rebonding and/or detailing bends are usually required, due to variations in tooth-surface morphology,[11-19] and inaccuracies in the direct bonding process.[11,14,18,19]

Insignia® is a custom fixed appliance system that fits the bracket bases to the existing contours of the teeth based on a scan of 3D image. The aligned bracket slots accommodate straight wires to move each tooth to the ideal final position as designed by the virtual set-up. Straight archwires are constructed as specified by the digital set-up, and the virtual bracket positions are transferred to the patient by bracket-positioning jigs. The custom design of the appliance eliminates wire bending and bracket rebonding, which provides for more effective mechanics to produce efficient treatment. For example, the current treatment of a severe Class III skeletal malocclusion (*DI 28*) was accomplished in only 10 appointments over 15 months. Only a single wire-bending adjustment was performed in the detailing phase, and that problem was due to an error in the initial digital set-up. The patient and the clinicians were well satisfied with the benefits of digital orthodontics.

Progressive archwire sequence

The Insignia® system permits clinicians "*to begin with the end in SIGHT.*" Therefore, the keys to efficient progression of treatment are: 1. provide an accurate prescription for the custom appliance, 2. follow the recommended archwire sequence, and 3. apply auxiliaries such as intermaxillary elastics as indicated. The clinical objectives are to: 1. ensure patient comfort, 2. maximize the potential of each step in treatment, and 3. achieve adequate alignment to place the final archwire as soon as possible (*Table 3*).[20]

Compared to traditional progressive archwire therapy, the Insignia® system reverse engineers the bracket slot for each tooth to achieve ideal alignment relative on a full-sized archwire. To achieve the full potential of the system, it is crucial to bond each bracket precisely utilizing the jig provided. If a bracket comes loose, it must be rebonded with the custom jig. The archwire sequence (*Table 2*) is designed to provide a minimal effective load to move all teeth as atraumatically as possible for a given stage of treatment, but it is not a "*cookbook*." As with any orthodontic appliance clinicians must use clinical judgement in applying force to teeth. The most malposed tooth receives the highest direct load from the archwire, and then indirectly loads all the teeth on a continuous archwire. It may be necessary to use clinical judgement in selecting teeth to not fully engage

Insignia Archwire Sequencing			
I	Stock light round wires	0.014 0.016 / 0.018 (alternative)	Stock Damon CuNiTi
II	Insignia edgewise CuNiTi wires	0.014 x 0.025 0.018 x 0.025 0.021 x 0.025	Insignia CuNiTi
III	Major mechanics	0.019 x 0.025	Stock SS
IV	Finishing	0.021 x 0.025 0.021 x 0.025 0.019 x 0.025 (backup)	Insignia CuNiTi Insignia TMA Insignia TMA

■ Table 3:
The recommended archwire sequence is summarized for progressive archwire therapy utilizing the Insignia® bracket system.

initially, and then adjust the time that an archwire is used to achieve the intended objective for that wire. Under routine circumstances, overloading individual teeth is not a problem with the Insignia® system, because very flexible initial wires (*e.g. 0.014-in CuNiTi*) can be fully engaged to prepare for the subsequent progressive sequence of wires. However, if a bracket must be rebonded or reengaged on the archwire, the clinician must be alert to overloading the affected tooth with the archwire currently in use. It may be necessary to drop back to a more flexible archwire to align all teeth to atraumatically receive the next, more rigid archwire.

Controlling PDL compressive stress

Controlling PDL compressive stress is a high priority for optimal performance of advanced mechanics. The Insignia® system is an ideal, fixed appliance platform for developing a new generation of biomechanics to enhance the rate of tooth movement and decrease the incidence of root resorption.[20] Under routine clinical circumstances, the well designed custom appliance eliminates bracket rebonding and wire bending to finish the correction. Going directly from start to finish with "*the end in sight*" controls the episodes of PDL necrosis associated with engaging active archwires.[5] The next horizon is development of multiform archwires that deliver optimal force to each tooth with a long range of superelastic activation. This advance would substantially reduce the number of progressive archwires required for treatment, and thereby decrease the episodes of PDL necrosis during active treatment.[5]

Conclusions

1. The Insignia® system reverse engineers the

bracket slot for each tooth to achieve ideal alignment when engaged on a full-sized archwire.

2. Assuming compliance with application of the brackets, archwire sequence, and application of auxiliaries, the Insignia® system provides very efficient treatment, decreased treatment time, and optimal outcomes.

3. Eliminating bracket repositioning and archwire adjustments saves chair time, decreases the number of appointments, minimizes PDL compressive stress, as well as controls episodes of PDL necrosis and root resorption.

4. A customized digital appliance focuses mechanics directly on the desired outcome.

Acknowledgment

Thanks to Mr. Paul Head for proofreading this article.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 28

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 = 7

Total = 7

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 = 2

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	4 pts.
Beyond Class II or III	=	1 pt. per mm. additional	____ pts.

Total = 4

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 = 4

OTHER (See Instructions)

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

Identify: Ectopically erupted maxillary canines

Total = 4

IMPLANT SITE

Lip line : Low (0 pt), Medium (1 pt), High (2 pts) =_

Gingival biotype : Low-scalloped, thick (0 pt), Medium-scalloped, medium-thick (1 pt), High-scalloped, thin (2 pts) =_

Shape of tooth crowns : Rectangular (0 pt), Triangular (2 pts) =_

Bone level at adjacent teeth : ≤ 5 mm to contact point (0 pt), 5.5 to 6.5 mm to contact point (1 pt), ≥ 7mm to contact point (2 pts) =_

Bone anatomy of alveolar crest : H&V sufficient (0 pt), Deficient H, allow simultaneous augment (1 pt), Deficient H, require prior grafting (2 pts), Deficient V or Both H&V (3 pts) =_

Soft tissue anatomy : Intact (0 pt), Defective (2 pts) =_

Infection at implant site : None (0 pt), Chronic (1 pt), Acute(2 pts) =_

Total = _____

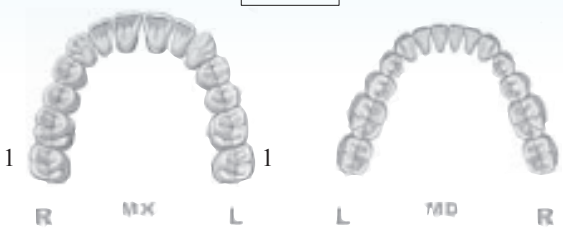
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 16

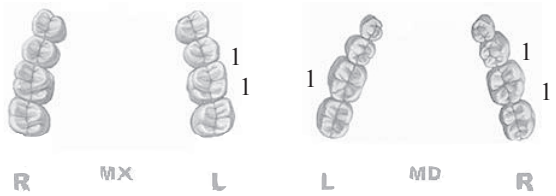
Alignment/Rotations

2



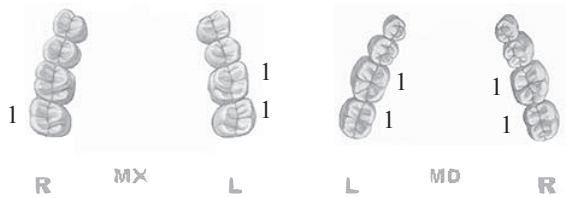
Marginal Ridges

5



Buccolingual Inclination

7

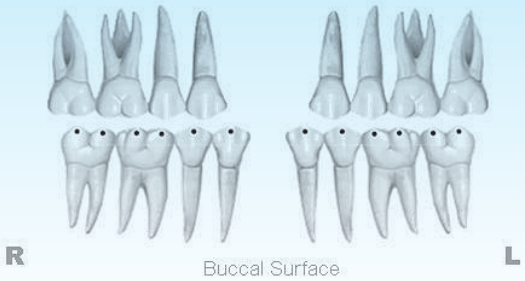


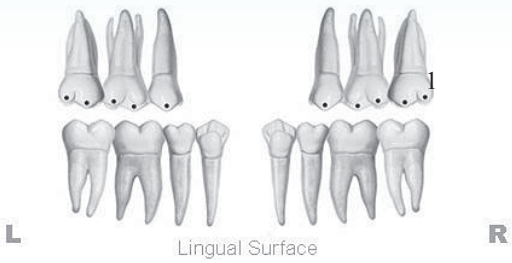
Overjet

1

Occlusal Contacts

0



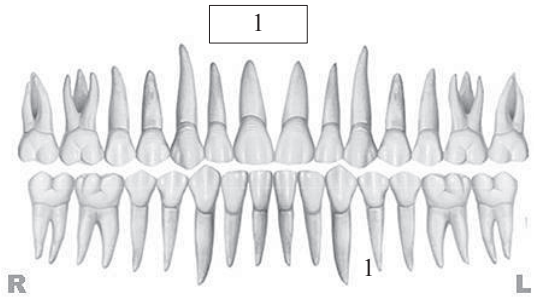


Occlusal Relationships

0

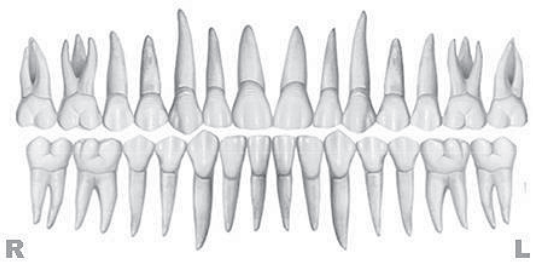
Interproximal Contacts

1



Root Angulation

0



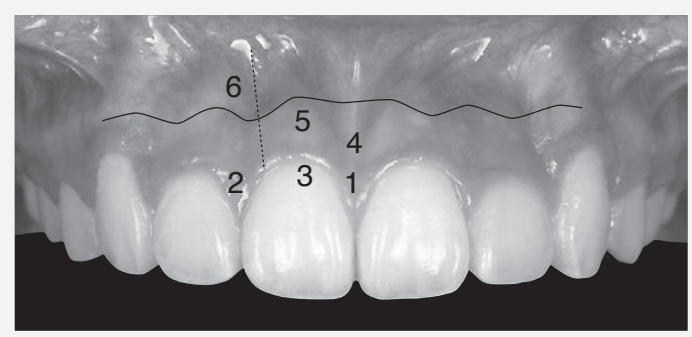
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 1

1. Pink Esthetic Score

Total = 0

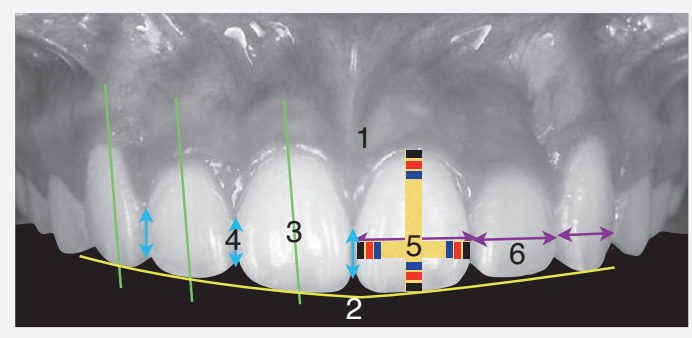


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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

2. White Esthetic Score (for Micro-esthetics)

Total = 1



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

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

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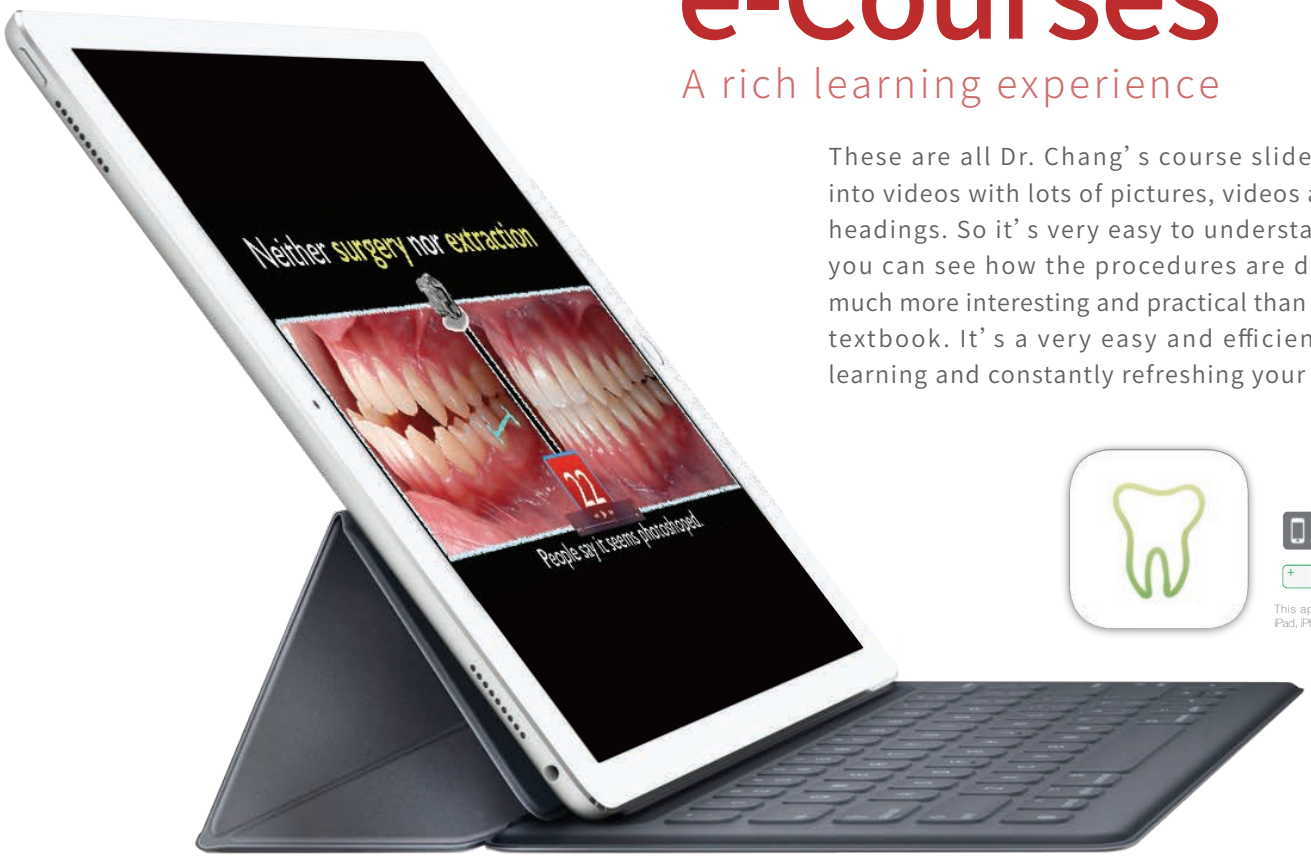

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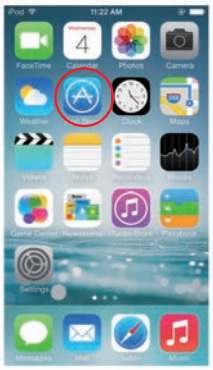
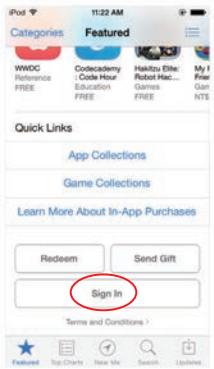
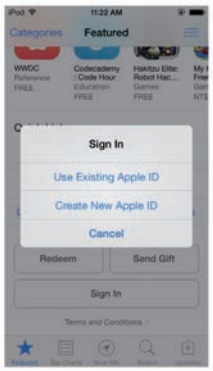
Step-by-step Instructions



1. Go to App Store on your device.

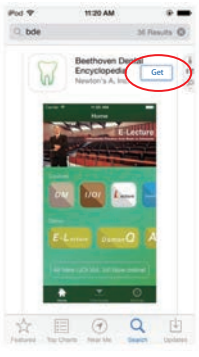


2. "Sign in" with your Apple ID.

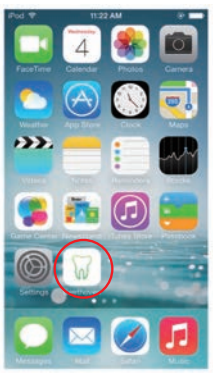


3. "Create Apple ID" if you don't have one.

4. Search for "BDE."



5. Click "FREE" and "INSTALL APP."



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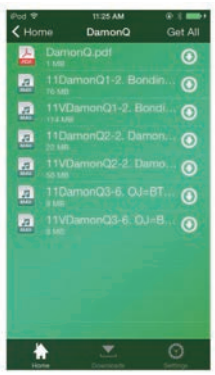

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Newton's A

Simplified Mechanics for Gummy Smile Correction

Abstract

This case report describes the interdisciplinary treatment of a 25-year-old woman presenting with chief complaints of bimaxillary protrusion and excessive gingival display ("gummy smile"). She was dissatisfied with her previous non-extraction orthodontic treatment, rendered at age 10. The Discrepancy index (DI) for this severe malocclusion was 21. Orthodontic treatment involved extraction of four premolars to correct protrusion, and skeletal anchorage via four miniscrews (2 anterior and 2 posterior) to intrude the entire maxillary arch. Space closure utilizing maxillary extra-alveolar (E-A) bone screws reduced lip protrusion and the anterior miniscrews were used to intrude the maxillary incisors. Following orthodontics, surgical crown lengthening was performed in the maxillary anterior segment. 32 months of interdisciplinary treatment resulted in a near ideal result as evidenced by a Cast-Radiograph Score (CRE) of 15 and Pink & White (dental esthetic) score of 3. (Int I Ortho Implantol 2017;47:72-91)

Key words:
Class I malocclusion, bimaxillary protrusion, surgical crown lengthening, self-ligating appliance, gummy smile

History and Etiology

A 25-year-old woman presented with a history of non-extraction orthodontic treatment, and a labial frenectomy to close the diastema between the upper central incisors, at age 10. The current concerns were bimaxillary protrusion and a gummy smile (*Fig. 1*). A functional exam documented lip incompetence with a hyperactive mentalis muscle to achieve lip closure. Clinical examination revealed a severe bimaxillary protrusion, gummy smile, lip incompetence and short clinical crowns. Mild crowding was noted in the lower dentition (*Figs. 2 and 3*). Comprehensive orthodontic treatment and surgical crown lengthening resulted in a pleasing outcome as documented in Figs. 4-9.

Diagnosis

Skeletal:

1. Slightly retrusive mandible (*SNA 78º, SNB 75º, ANB 3º*)
2. High mandibular plane angle (*SN-MP 41º, FMA 32º*)

Dental:

1. Class I molar relationship, midlines were coincident
2. Short clinical crowns due to altered passive eruption, type I, B
3. Overjet (*5mm*)

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Fig. 1: Pre-treatment facial photographs

Fig. 4: Post-treatment facial photographs

Fig. 2: Pre-treatment intraoral photographs

Fig. 5: Post-treatment intraoral photographs

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

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

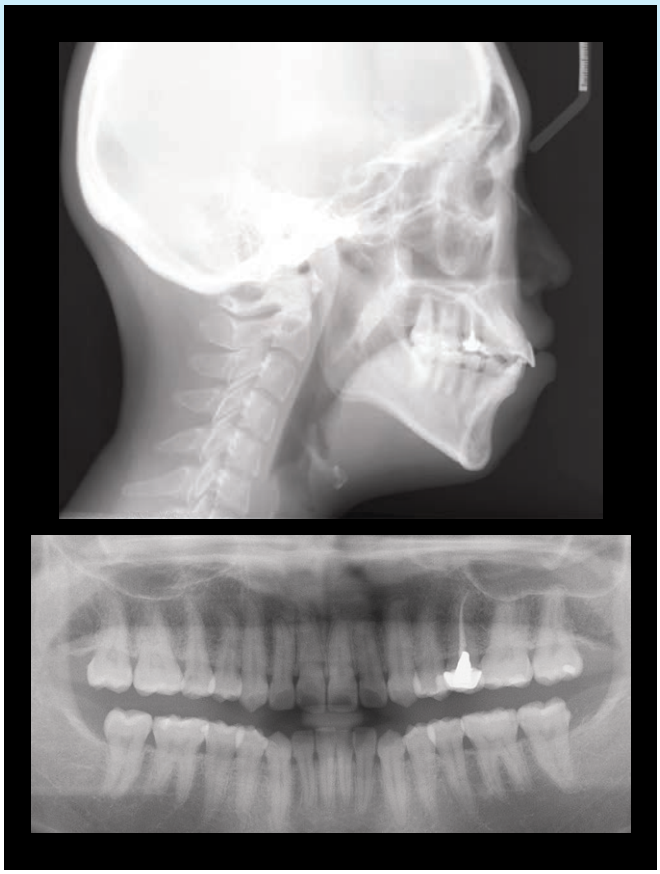


Fig. 7:
Pre-treatment lateral cephlometric and panoramic radiographs reveal root canal treatment in tooth #13. Bimaxillary protrusion and lip strain on closure is noted in the cephalometric view.

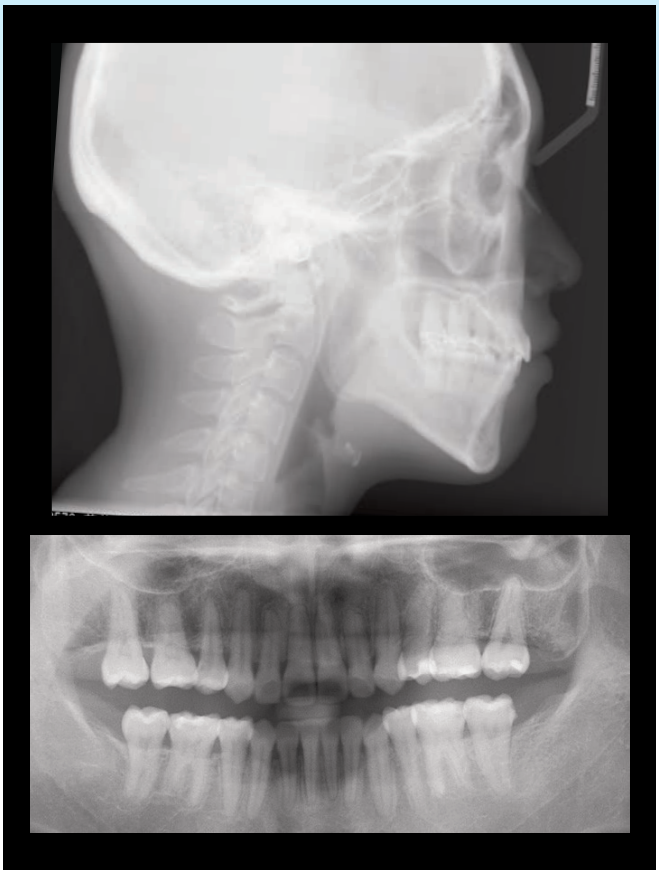


Fig. 8:
Post-treatment lateral cephlometric and panoramic radiographs document the orthodontic result.

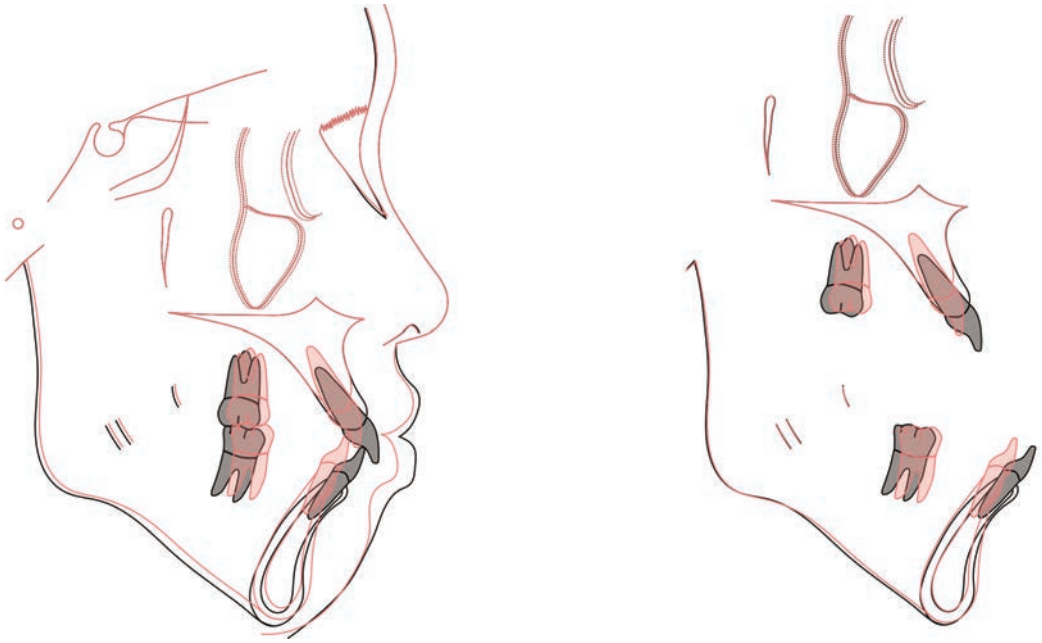


Fig. 9: Superimposed on the anterior cranial base, maxilla and mandible.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	78°	74°	4°
SNB° (80°)	75°	74°	1°
ANB° (2°)	3°	0°	3°
SN-MP° (32°)	41°	40°	1°
FMA° (25°)	32°	31°	1°
DENTAL ANALYSIS			
U1 To NA mm (*4 mm*)	10 mm	8 mm	2 mm
U1 TO SN° (104°)	110°	103°	7°
L1 To NB mm (*4 mm*)	8 mm	4 mm	4 mm
L1 TO MP° (90°)	95°	87°	8°
FACIAL ANALYSIS			
E-LINE UL (*2-3 mm*)	2 mm	-1 mm	3 mm
E-LINE LL (*1-2 mm*)	6 mm	1 mm	5 mm

■ Table 1: Cephalometric summary

Facial:

1. Convex profile with protrusive lips
2. Excessive maxillary gingival display when smiling

As shown in the subsequent worksheet, the American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) was 21. Cephalometric values are summarized in Table 1.

Specific Objectives of Treatment

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

- A - P: *Maintain*
- Vertical: *Decrease the vertical dimension of the occlusion (VDO)*
- Transverse: *Maintain*

Maxillary Dentition:

- A - P: *Retract incisors*
- Vertical: *Intrude the entire maxillary dentition, particularly the incisors*
- Inter-molar / Inter-canine Width: *Modest increase to articulate with the lower arch*

Mandibular Dentition:

- A - P: *Retract the mandibular incisors*
- Vertical: *Maintain*
- Inter-molar / Inter-canine Width: *Modest increase as buccal segments are uprighted*

Facial Esthetics:

- Retract lips and achieve lip competence

Treatment Plan

Extract one premolar in each quadrant (*teeth #5, 13, 21 and 28*). Bond all permanent teeth with the 0.022-in Damon Q® (*Ormco, Glendora, CA*) self-ligating bracket system. Use the stainless steel OrthoBoneScrew® (*OBS*) (*Newton's A, Ltd., Hsinchu, Taiwan*) anchorage system as follows: 1. 2x12mm screws in each infrazygomatic crest (*IZC*) to serve as E-A anchorage to retract and intrude the maxillary arch, and 2. 1.5x8mm interradicular screws bilaterally between the roots of the maxillary central and lateral incisors to intrude the maxillary anterior segment. When optimal alignment is achieved, remove all fixed appliances and fabricate clear overlay retainers.

Correct maxillary anterior dental and soft tissue proportions with a surgical crown lengthening procedure.

Appliances and Treatment Progress

Following permolar extractions, the 0.022-in Damon Q® system was bonded on all maxillary teeth, using high torque brackets in the anterior segment (*Fig. 10*). The following month, standard torque brackets were bonded on all mandibular teeth (*Fig. 11*). The wire sequence in the upper arch was: 0.014-in CuNiTi, 0.014x0.025-in CuNiTi, 0.017x0.025-in TMA, 0.019x0.025-in SS. The wire sequence in the lower arch was similar except that the final wire was 0.016x0.025-in SS. After the 0.019x0.025-in SS arch wires were inserted into the maxillary arch, power chains and Class II elastics (*Ormco 1/4-in 3.5-oz, Fox*) were applied to close all spaces. Twelve months into active treatment, a 2x12mm OBS was placed in each IZC for posterior maxillary anchorage, and two 1.5x8mm miniscrews were inserted between the upper central and lateral incisors (*Fig. 12*). Retracting the entire maxillary dentition with bony anchorage rotates the arch and extrudes the maxillary incisors, but OBS anchorage between the maxillary central and lateral incisors counteracts the anterior extruding force, resulting in intrusion of the entire maxilla1 (*Figs. 13-15*). Thus, the four OBS fixtures are a temporary anchorage device (*TAD*) to intrude the entire maxilla to help correct gummy smile. In the 23th month of treatment, two anterior bite turbos were bonded on the palatal surface of the maxillary central incisors and Class II elastics (*3.5-oz*) were used. The short anterior crowns appeared even shorter during the intrusion phase because of gingivitis (*Fig. 16*).

Fig. 10:
The maxillary right first (#5) and left second (#13) premolars were extracted and high torque brackets were bonded on the incisors.

Fig. 11:
The lower arch was bonded one month after the upper arch. Standard torque brackets were used on all teeth. Note that both first premolars were extracted.

Fig. 12:
Inter-radicular OBSs were inserted between the central and lateral incisors, and E-A OBSs were inserted in the zygomatic crests. Incisor intrusion was accomplished with elastomer chains.

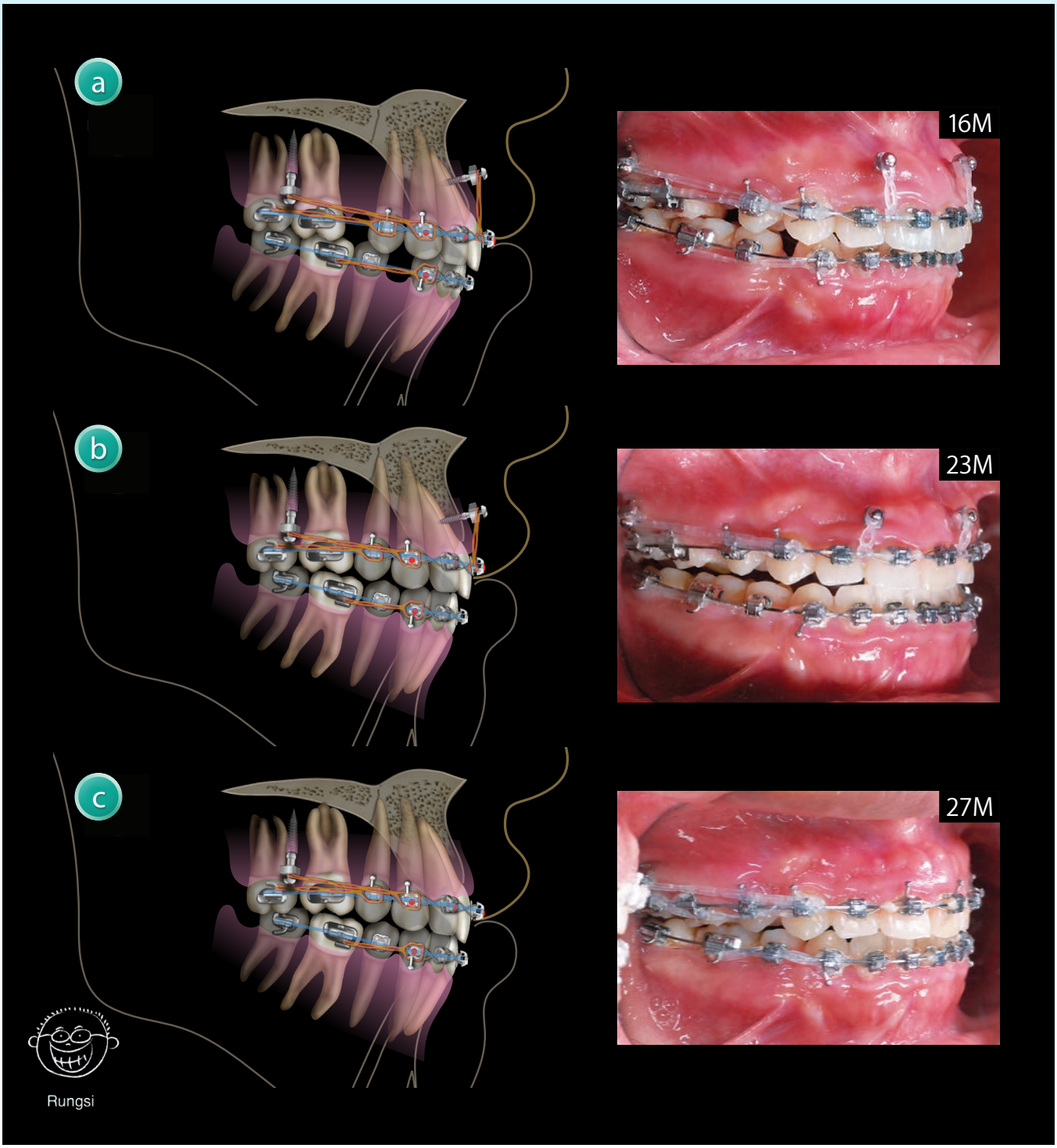
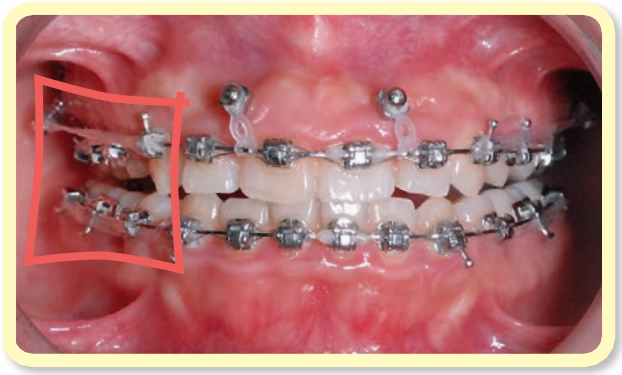


Fig. 13: Diagrams and corresponding photographs illustrate the mechanics employed at progressive stages of treatment:
a. At 16 months the occlusal plane was gradually steepening.
b. At 23 months anterior bite turbos were bonded on the palatal surfaces of the maxillary central incisors.
c. In the 27th month, retraction force from the IZC miniscrews closes upper space but also provides lingual crown torque to the upper incisors.

In the 24th month of treatment, the anterior OBSs were removed and the upper arch wire (*0.019x0.025-in SS*) was expanded to improve the posterior occlusion (*Fig. 14*). Class II elastic and anterior U shape vertical elastics were used from the 24th month until the 31th month.

In the 31th month of treatment, the arch wire was sectioned distal to the maxillary canines and bilateral rectangular shaped Fox (*1/4-in 3.5-oz*) elastics were utilized to settle the posterior occlusion.

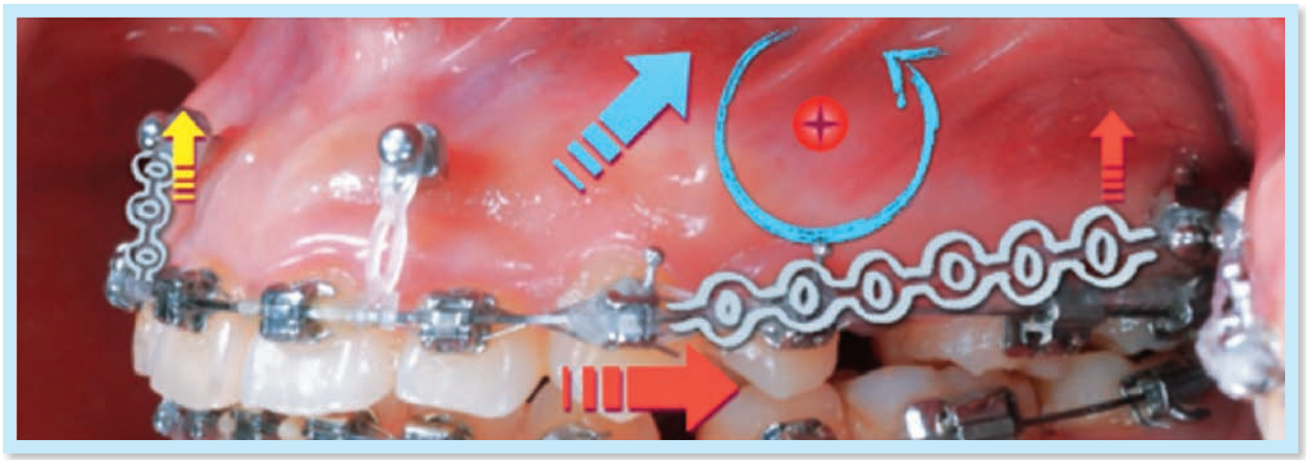


■ *Fig. 14:*
As extraction space was closed, the right buccal segment tended toward crossbite, so the archwire was expanded.

After orthodontic treatment was complete, surgical crown lengthening (*Figs. 17-19*) was performed to establish proper crown heights and proportions. The total active treatment time was 32 months.

Retention

Prior to debonding, all finishing discrepancies were assessed such as axial inclination of maxillary molars (*Fig. 20*). Many of these residual problems were corrected with posterior vertical elastics after the archwire was cut distal to the canines. After all labial appliances were removed, fixed retainers were bonded from 2-2 in the maxillary arch. Upper and lower clear overlay retainers were delivered. The patient was instructed to wear them full time for the first 6 months and nights only thereafter. Instructions were provided for home dental care, as well as for maintenance of the retainers.



■ *Fig. 15:*
The force systems provided by the four OBSs and their overall effect on the maxillary arch are complex. The yellow arrow on the left indicates the intrusive force applied to the incisors. The large red arrow is the retraction force anchored by the IZC OBS. The small red arrow is the intrusive component on the posterior maxillary segment. The large blue arrow is the net resultant force on the maxilla, and the blue circular arrow represents the moment of the retraction force around the center of resistance of the maxilla (red dot with a cross).

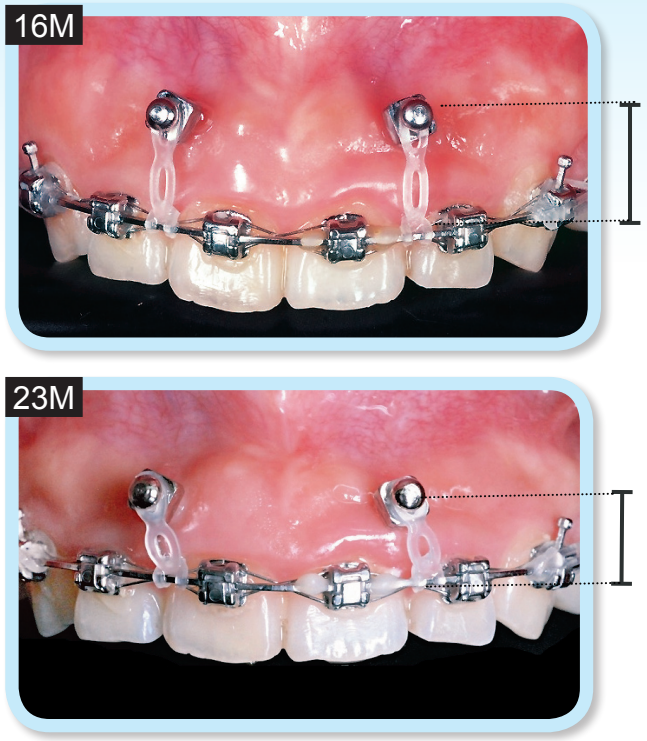


Fig. 16:
The distance of 3mm between the screws and main arch wire from 16th to 23rd month have been reduced.

Surgical crown lengthening process

According to Graber and Salama classification, This patient was classified to vertical maxillary excess degree II and corresponding treatment was periodontal and restorative therapy.[10] The procedure indicated is illustrated in Figs. 17-19. Under local anesthetic, the width of the dentinogingival complex was measured by sounding to bone with a periodontal probe (*Figs. 17b, c and 19*). Then the relationship of the cementoenamel junction (*CEJ*) to the osseous crest was mapped, and the width of the keratinized gingiva was determined (*Fig. 17d*). Although not necessarily essential for periodontal health, 2mm or more of keratinized gingiva certainly improves esthetics and is helpful for maintaining effective hygiene.[2] If there is not enough keratinized gingiva following the osteoplasty phase of the surgical crown lengthening procedure, an apically positioned flap is indicated.

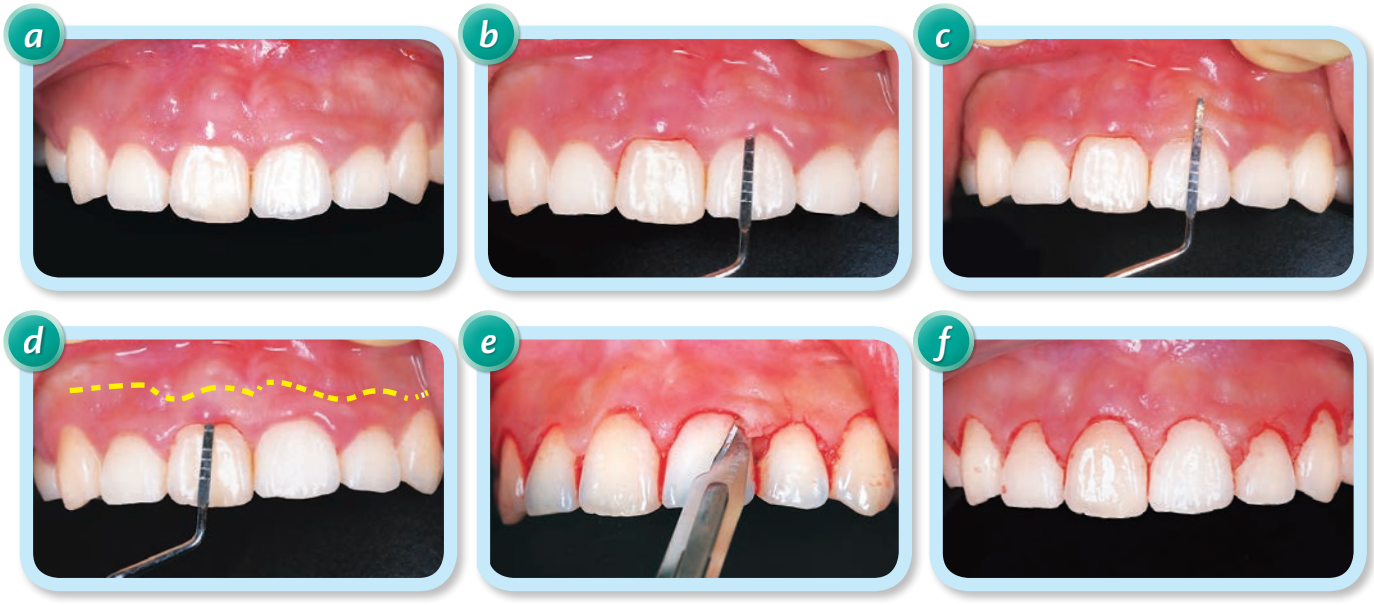


Fig. 17:
The surgical crown lengthening procedure for short clinical crowns (a) begins with bone sounding (b) relative to the attached gingiva (c). The width of the attached gingiva is mapped with a dotted line (d). The gingivectomy is performed with a No. 15 blade (e) and the increased crown exposure (f) is assessed relative to the width of the remaining attached gingiva.

Excess gingiva was resected using an intrasulcular incision to establish the desired crown length. In the absence of severe dental attrition, the CEJ was the best anatomical reference for the gingivectomy (*Fig. 17*) and the osteotomy (*Fig. 18*) to provide for an adequate biologic width. Once the desired crown exposure was achieved, the gingival flap was raised and bone removal was performed with a #5 round carbide bur to establish a uniform biologic width (*CEJ to alveolar crest*) of at least 2.5mm for the anterior teeth. For example, there was only 1mm of biologic width along some aspects of the facial surface of tooth #9 (*Fig. 18a*). So trimming bone to establish a uniform biologic width of 2.5mm was essential for long-term gingival health. Finally the flap was repositioned to the crowns and sutured about 0.5mm coronal to the CEJ (*Fig. 18c*).

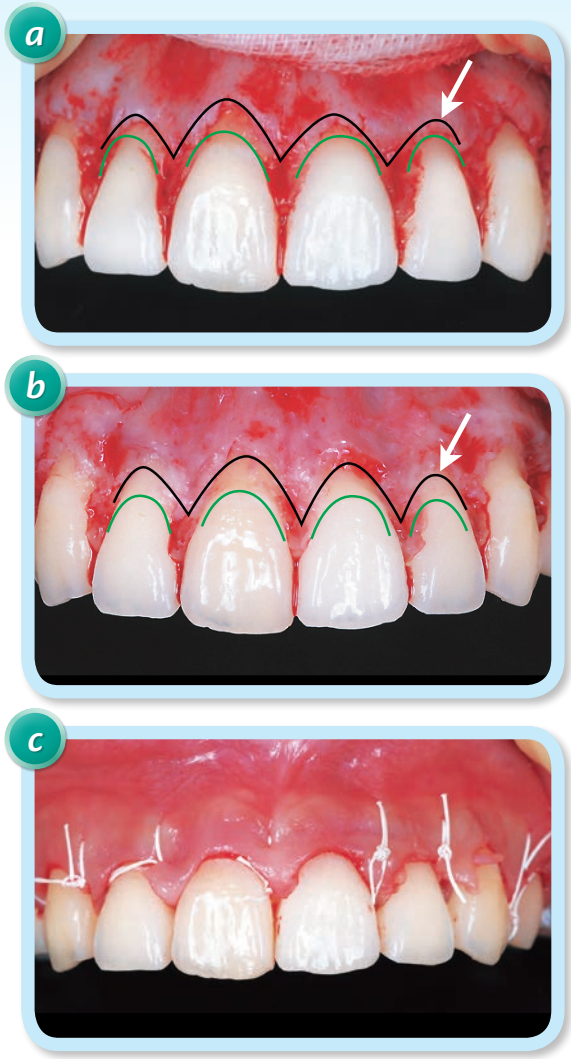


Fig. 18:
Green lines represent the CEJs and black lines are the alveolar bone level before osteoplasty (a). The white arrow (a) shows that the biologic width of #10 was only ~1mm (b). After osteoplasty (b) the biologic width was corrected to 2.5mm, and the gingiva was sutured with #4 Gore-Tex® (Gore Medical Products, Flagstaff, AZ).

Final Evaluation of Treatment

Alignment: the ABO Cast-Radiograph Evaluation (*CRE*) score was 15 points, which is an excellent result for a malocclusion presenting with a DI=21. Most of the residual alignment problems were due to bracket positioning errors. The importance of precise bracket placement cannot be overemphasized.

Esthetics: the Pink and White Dental Esthetics score was assessed before and after crown lengthening surgery. The Pink Esthetics score (*gingival aspects*) significantly improved from 4 to 2 points because of the surgical crown lengthening. Residual discrepancies post-operatively were the curvature and level of the gingival margins. Selective gingivectomy with a dioxide laser is indicated to resolve these problems. The White Esthetics score (*dental aspects*) also improved from 3 points to 1 after crown lengthening surgery. The incisal curve remained uneven due to the attrition of tooth #9. Direct bonding with composite resin and/or selective grinding is indicated.

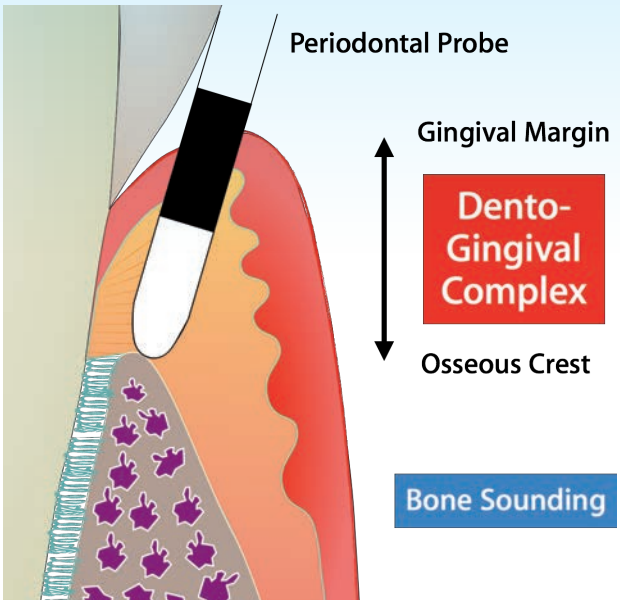


Fig. 19:
The dentogingival complex can be measured by bone sounding with a periodontal probe. The dimensions of the normal dento-gingival complex are approximately 3.0mm buccally and lingually, with a mean of 4.5 to 5.0mm interproximally.[3]

Overall, the maxillary dentition was intruded and the anterior teeth were retracted (*Fig. 9*). The gummy smile and the protrusive lips were significantly improved (*Fig. 4*). The patient was well satisfied with the result.

Discussion

From an esthetic perspective, the ideal is 1-2mm of gingival display when smiling.[4] Excessive gingival exposure when smiling may be localized or involve all of the maxillary teeth. A "*gummy smile,*" may have both an extra-oral and intra-oral etiology.[5]

Extra-oral causes:

1. **Short Upper Lip**: Lip length is normally about one third of lower facial height. Clinically, lip length is measured from subnasale to the inferior border of the upper lip (*Fig. 20*). Individuals with less than 20mm of lip length are usually classified as having a short lip.[6]

2. **Hypermobile Upper Lip (HUL)**: The average lip mobility from repose and a full smile is ~6-9mm. The distance the upper lip travels when smiling is determined by measuring from a baseline, which is the lip position at rest; measure the distance from the maxillary incisor edge to the lower border of the lip on the lateral cephalometric film or the facial photograph if the incisor is visible. Then measure the distance form the incisor edge to the inferior border of the lower lip on the facial photograph when smiling. If the total distance that the lip travels when smiling is greater than ~ 6-9mm, the diagnosis is hypermobile lip. The underlying etiology is usually hyperactivity of the upper lip elevator muscles.

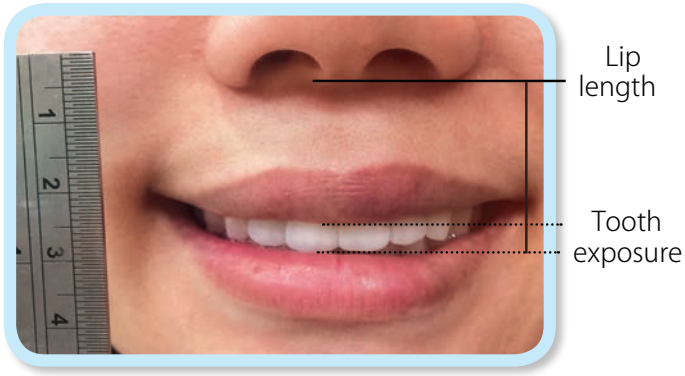


Fig. 20:
Ideal lip length in young adult females is from 20 to 22mm, whereas it is from 22 to 24mm in young adult males.[6]

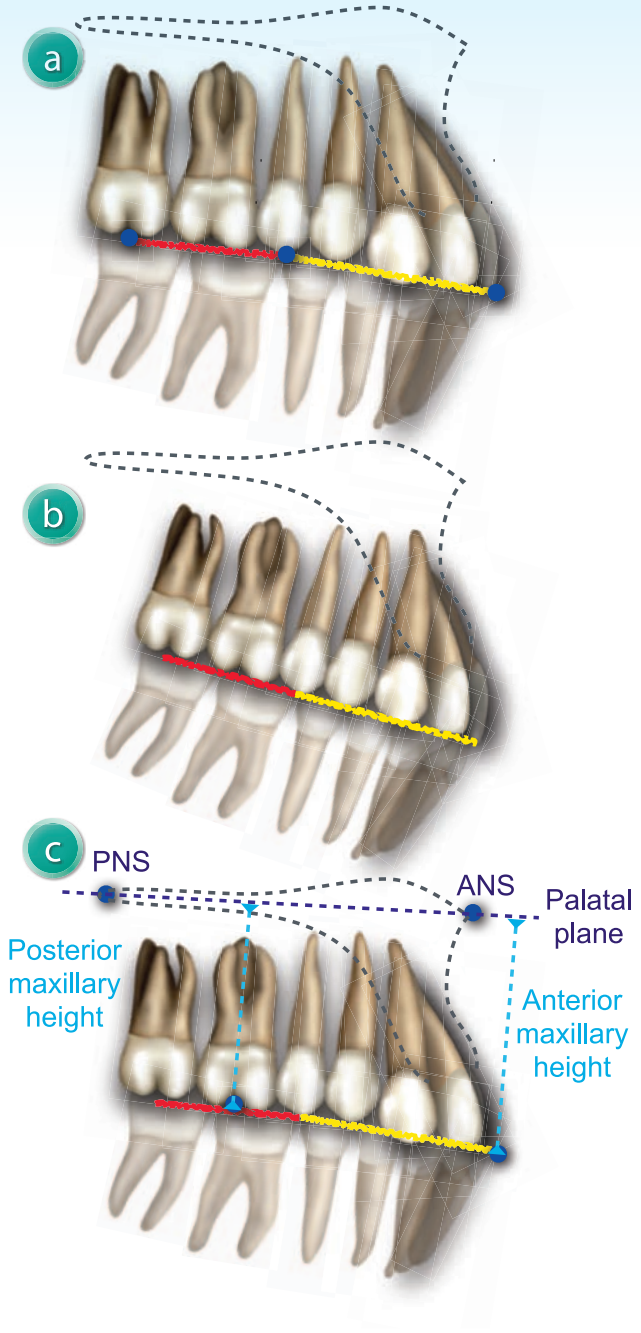


Fig. 21: Occlusal plane canting in the sagittal plane:

a. In anterior dentoalveolar extrusion (ADE), only the anterior portion of the occlusal plane is canted inferiorly.

b. Vertical maxillary excess (VME) involves inferior positioning of both the anterior and posterior segments with a flat but often steep occlusal plane.

c. Anterior and posterior maxillary height are measured cephalometrically as shown.[7,8]

3. **Anterior Dentoalveolar Extrusion (ADE)**: This condition may be associated with incisor attrition and/or a deep bite (*Fig. 21a*). As the maxillary incisors extrude to make contact (*passive eruption*), there is excessive gingival display and a curvature of the occlusal plane, which is associated with a disharmony between the anterior and posterior segments.[2] This condition can be corrected by intruding the upper anterior teeth with miniscrew anchorage.[6]

4. **Vertical Maxillary Excess (VME)**: The maxilla is more inferiorly positioned due to increased lower facial height and there may be a cant in the occlusal plane. The average anterior maxillary height is 29.7mm,[6] whereas the average posterior maxillary height is 20.6mm.[9] The current patient's anterior and posterior maxillary heights were 29 and 25mm respectively, which is not consistent with either ADE or VME. However, these cephalometric measurements are only averages. A thorough diagnosis for an individual patient must be more comprehensive. Gummy smile is a clinical impression, not a cephalometric value.

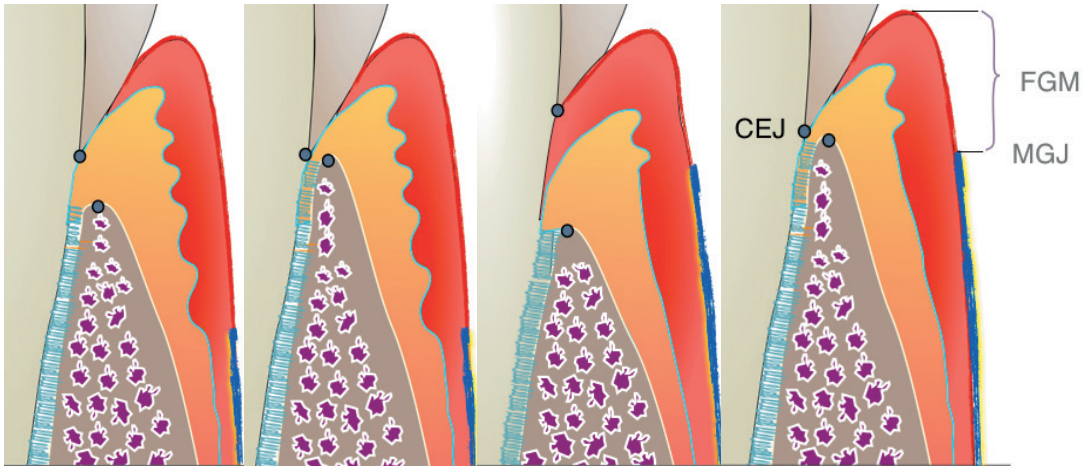
Garber and Salama (*2000*)[10] classified the degree of VME and corresponding treatment modalities. The alternative to orthognathic surgery was the use of bilateral anterior and posterior miniscrews to achieve intrusion of the anterior teeth and retraction of the entire arch. Once anterior teeth were intruded to the desired level, trimming the upper incisors to the desired height and a crown lengthening procedure were indicated to provide an optimal esthetic result. Furthermore, for the patients with more than 5mm gingival display, lip reposition surgery and

Botox® (*Allergan Inc. Irvine, CA*) injection are viable alternatives to orthognathic surgery.[11,12]

Intra-oral causes:

1. **Gingival Enlargement**: Enlarged gingival tissues may be due to infection or sensitivity to medication (*e.g. phenytoin, cyclosporine, calcium channel blockers etc*). The treatment for this condition should focus on oral hygiene, but a gingivectomy may be necessary in some cases.[1]

2. **Altered Passive Eruption**: Tooth eruption is divided into two phases: active and passive eruption. Active eruption is the movement of the teeth in the direction of the occlusal plane, whereas passive eruption is the exposure of the teeth by apical migration of the gingiva.[13] Tooth eruption continues throughout life and the level of free gingival margin varies accordingly. Goldman and Cohen (*1968*)[14] coined the term "altered passive eruption" for failure of the gingival margin to recede to a level apical to the cervical convexity of the crown. Volcansky and Cleaton-Jones (*1976*)[14] reported that 12.1% of 1,025 patients with a mean age of 24.2 years ± 6.2 years displayed altered passive eruption.[14] It is more prevalent in women than in men. Depending on the level of mucogingival junction (*MGJ*) and alveolar bone crest, there are four types of altered passive eruption: Type IA, type IB, type IIA and type IIB (*Fig. 22*).[15] The difference between Class I and II is the width of keratinized gingiva (*soft tissue*). The difference between subtype A and B is the level of alveolar bone crest. For the current patient, bone



	Type I, A	Type I, B	Type II, A	Type II, B
Gingivectomy	O	O	X	X
Osteoplasty	X	O	X	O
APF	X	X	O	O

Fig. 22:
Classification of altered passive eruption is important for determining the most appropriate surgical procedure(s) to correct it.[15]

sounding favored a diagnosis of type IB, which can be reliably treated with gingivectomy and osteoplasty (*Figs. 23 and 24*).

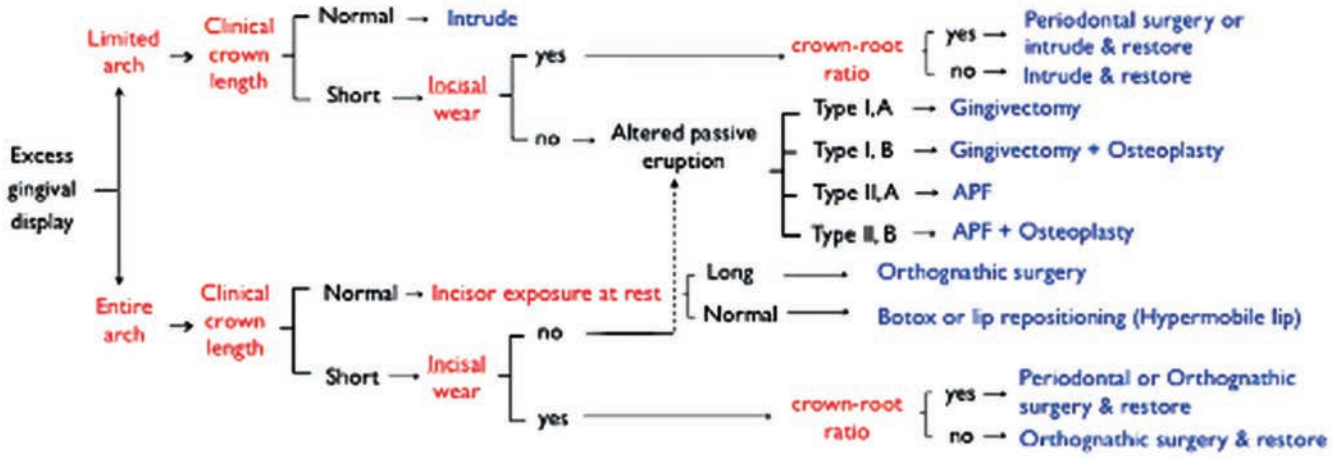
Decision tree[5]:

The occlusal plane favors ADE (*Fig. 21a*) because only the anterior segment was tilted inferiorly. For VME (*Fig. 21b*) both the anterior and posterior occlusal planes are inferiorly positioned, and the occlusal plane is flat. ADE can often be treated with orthodontic intrusion but VME may require orthognathic surgery, usually a Lefort 1 osteotomy.

Clinical crown length measurement using a gauge or periodontal probe is the second determinant of an effective decision making process. When compared to normal crown length of a central incisor (~*11mm*) a patient's incisors can be classified as short, average or long.

Incisal wear is the third determinant. If there is excessive dental attrition, it is important to intrude the affected teeth to correct the level of the gingiva, and then restore the incisors to normal length. Since a history of excessive incisal wear is usually associated with nocturnal parafunction, it is essential to retain the patient with a Hawley bite plate that slightly opens the posterior bite. The bite plate should be worn at night indefinitely to protect the restorations.

Incisor exposure when resting is the fourth determinant. If the patient cannot completely close the lips in repose, and incisor exposure at rest is more than 2mm, VME is the probable diagnosis, and orthognathic surgery may be necessary. If the patient can close the lips at rest, but the gingival display is over 4 mm when smiling, the diagnosis is hypermobile lip. Botox® injections and/or surgical lip repositioning is suggested.[11,12]



■ *Fig. 23:*
The decision tree is a flow chart for assessing excessive gingival display to determine the most appropriate clinical management for a specific problem. The five determinants for decision making are: extent of the excessive gingival display, clinical crown length, incisal wear, incisor exposure at rest, and the crown-root ratio.[5]

The crown to root ratio is the fifth determinant. If the alveolar bone supporting tooth roots is adequate, the overall treatment time can be reduced by surgical crown lengthening without orthodontic intrusion.

A comprehensive diagnosis and effective treatment plan for gummy smile requires a careful analysis of the five determinants of the decision tree.[5] For the present patient, the findings were VME, short clinical crown length, and no incisal wear. So the diagnosis

Fig. 24: Smile type is classified as follows:[16]

a. *Commissure smile is a Cupid's Bow configuration that is seen in ~67% of the population. The corners of the mouth are elevated and projected anteriorly by the levator muscles of the upper lip. The teeth are exposed in a smile arc with a base at the incisal edge of the maxillary central incisor.*

b. *Cuspid smile is seen in ~31% of the population. The shape of the lips is commonly visualized as a diamond. The levator labii superior muscles contract first, exposing the maxillary cuspids, then the corners of the mouth contract projecting the lips upward and outward.*

c. *Complex smile is seen in ~2% of the population. The shape of the lips are typically illustrated as two approximating chevrons. The levators of the upper lip and corners of the mouth contract simultaneously with the depressors of the lower lip, to expose all the upper and lower teeth.*

Fig. 25: Smile line is classified as follows:[17]

a. *Low smile line, exposing less than 75% of the maxillary incisors and no gingiva, is seen in 20.48% of the population.*

b. *Average smile line, exposing 75-100% of the maxillary anterior teeth along with interproximal gingiva, is seen in 68.94% of the population.*

c. *High smile line, exposing 100% of the anterior segment along with a contiguous band of gingiva., is seen in 10.57% of the population.*

was altered passive eruption (*Fig. 23*). Measuring the width of keratinized gingiva and bone sounding determined that the present case was type I B, and the corresponding treatment following completion of orthodontics was gingivectomy and osteoplasty (*Figs. 22 and 23*). Using the decision tree (*Fig. 23*), the dental practitioner may approach this type of patient with confidence.

Philips[16] established a plastic surgery classification based on three smiling patterns: commissure, cuspid or complex smile. The variation among these smile types is due to the differential function of facial muscle groups. The esthetic appearance of gingival tissue varies widely and must be specifically evaluated for each individual.

Tjan and Miller[17] published a dental smile classification system that distinguished individuals with a low, average and high smile line, based on the amount of dental and gingival exposure during a natural full smile (*Fig. 25*). The high smile line, also known as a gummy smile, is generally an esthetic concern which is twice as common in women compared to men. The authors[17] proposed that women have a shorter upper lip than men, but this hypothesis was not be confirmed in subsequent studies.[18]

Kaya and Uyar[19] found that the dominant factors affecting the perception of smile attractiveness are smile arc and gingival display. Furthermore, flat smile arcs are preferred when there is insufficient gingival display, but the vaulted smile arc is preferred with

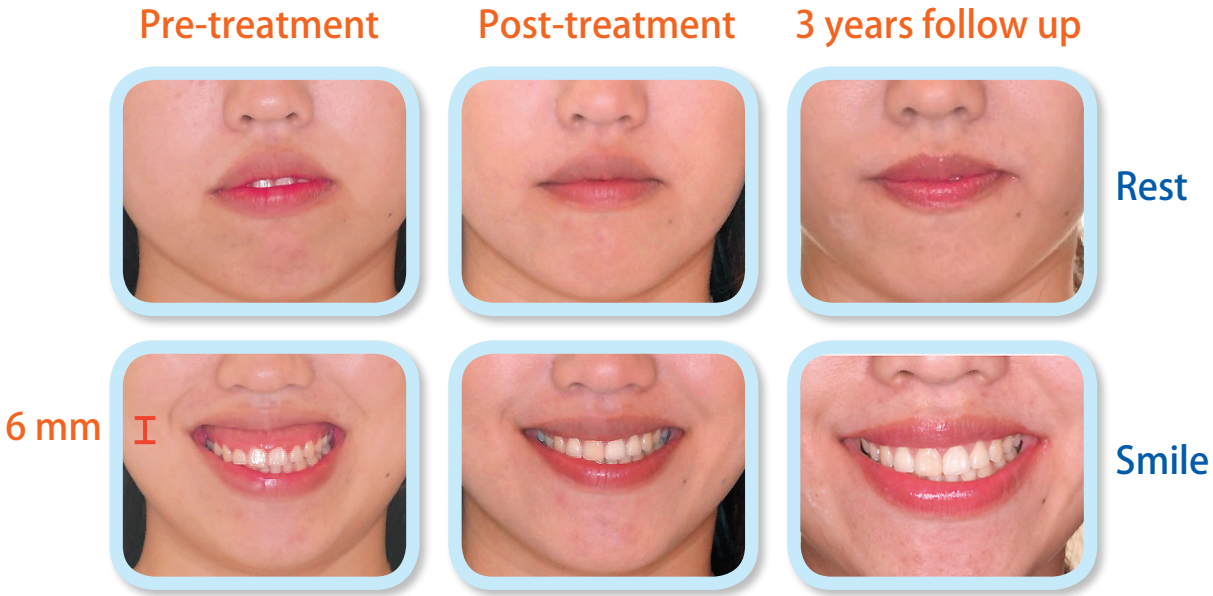


Fig. 26:
Pre- and post-treatment images of the current patient's smile. The gummy smile has been improved remarkably by orthodontics and surgical crown lengthening.

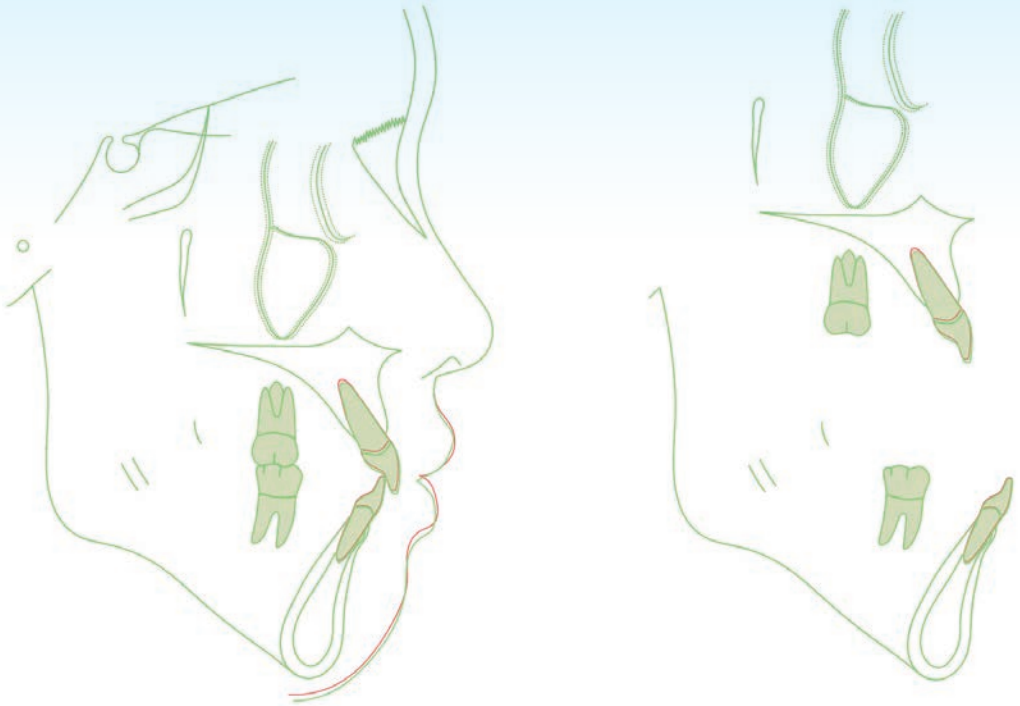


Fig. 27:
Superimposed on the anterior cranial base, maxilla and mandible. The upper and lower dentition remain stable. No relapse was noted.

excessive gingival display. In an aging study, Vig and Brundo[20] reported that the maxillary central incisor exposure gradually decreases over time and is accompanied by a corresponding increase in mandibular tooth exposure.

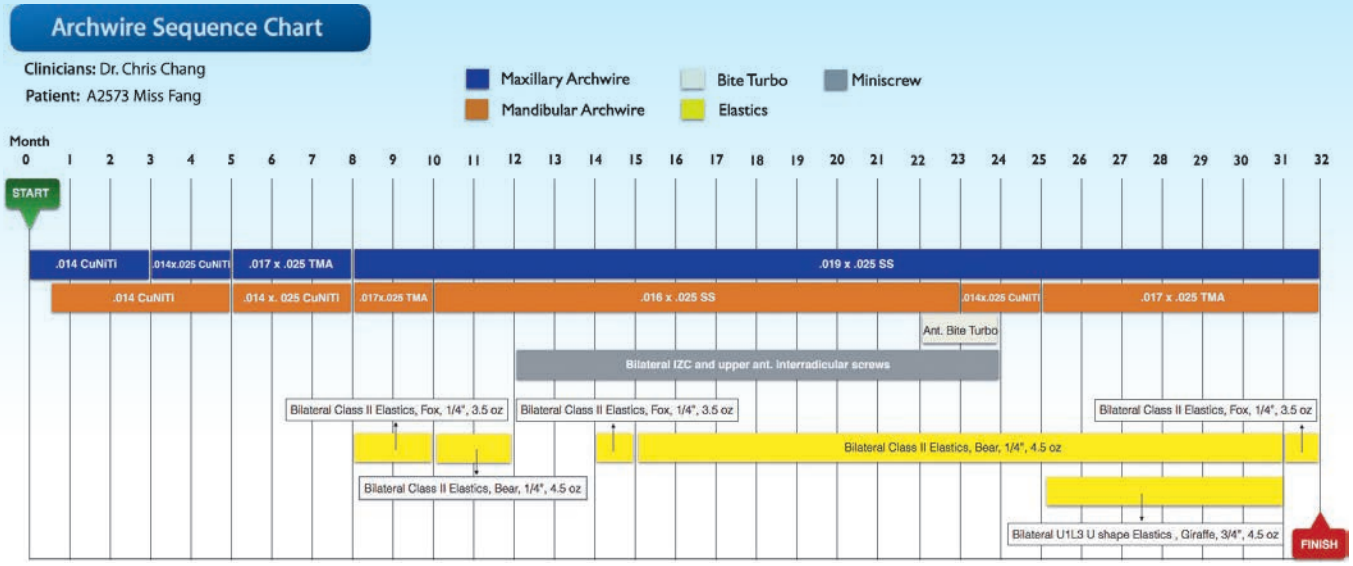
With respect to the current patient, a high smile line was changed to average by intruding the entire maxillary arch with anterior and posterior OBS anchorage (*Fig. 26*). The treatment effect is similar to a LeFort I osteotomy and result is stable, thereby offering patients a viable alternative (*Fig. 27*). Combining intrusion and surgical crown lengthening produced an attractive smile without the cost, morbidity and potential complications of orthognathic surgery.

Conclusion

Darwin[21] stated that we all smile in the same language. The smile is the most recognized human expression. However, excessive gingival display is a major concern for many patients who subsequently seek esthetic dental treatment. By measuring a set of pretreatment parameters, an accurate diagnosis is achieved for guiding conservative treatment that is effective for alleviating gummy smiles.

Acknowledgment

Thanks to Mr. Paul Head and Dr. Bill Su for proofreading this article and Dr. Rungsi and Dr. CK Chen for sharing their ideas and material.



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Discrepancy Index Worksheet

TOTAL D.I. SCORE 21

OVERJET

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

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

Total = 2

OVERBITE

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

Total = 2

ANTERIOR OPEN BITE

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

Total = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

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

Total = 7

OCCLUSION

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

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	3 x 2 pts. =	6

Identify: Severe gummy smile and bimaxillary protrusion

Total = 6

IMPLANT SITE

Lip line : Low (0 pt), Medium (1 pt), High (2 pts) = _____

Gingival biotype : Low-scalloped, thick (0 pt), Medium-scalloped, medium-thick (1 pt), High-scalloped, thin (2 pts) = _____

Shape of tooth crowns : Rectangular (0 pt), Triangular (2 pts) = _____

Bone level at adjacent teeth : ≤ 5 mm to contact point (0 pt), 5.5 to 6.5 mm to contact point (1 pt), ≥ 7mm to contact point (2 pts) = _____

Bone anatomy of alveolar crest : H&V sufficient (0 pt), Deficient H, allow simultaneous augment (1 pt), Deficient H, require prior grafting (2 pts), Deficient V or Both H&V (3 pts) = _____

Soft tissue anatomy : Intact (0 pt), Defective (2 pts) = _____

Infection at implant site : None (0 pt), Chronic (1 pt), Acute(2 pts) = _____

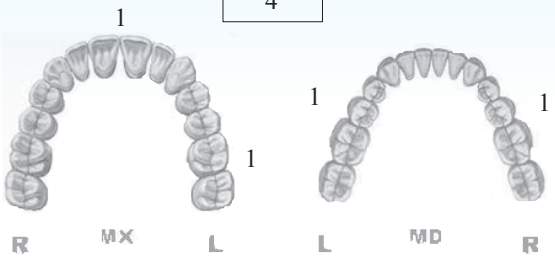
Total =

Cast-Radiograph Evaluation

Total Score: 15

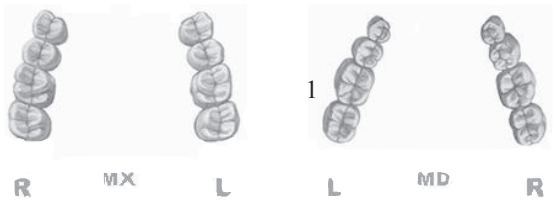
Alignment/Rotations

4



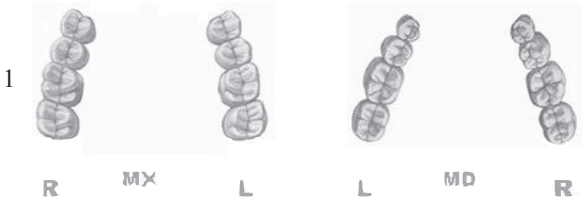
Marginal Ridges

1



Buccolingual Inclination

1

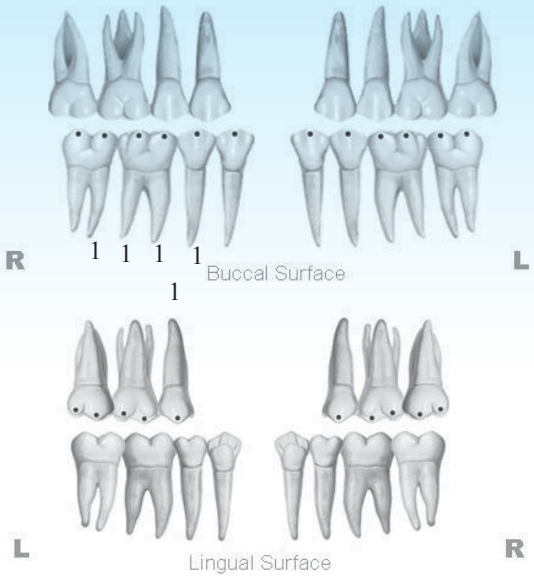


Overjet

0

Occlusal Contacts

5

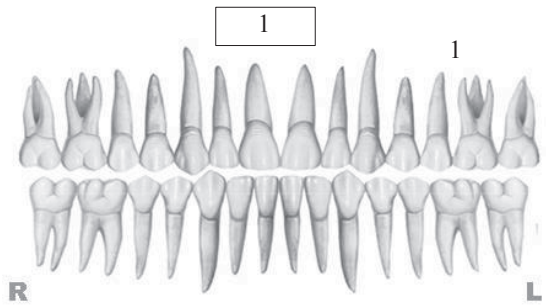


Occlusal Relationships

0

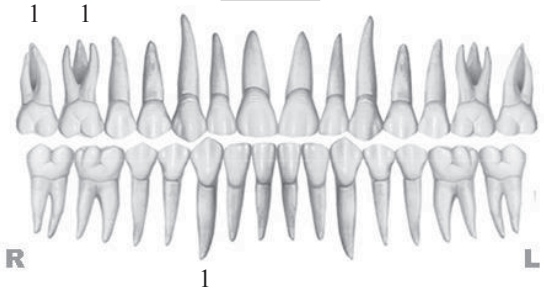
Interproximal Contacts

1



Root Angulation

3



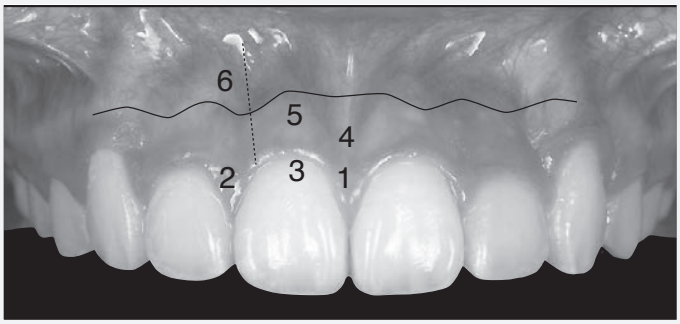
***INSTRUCTIONS:** Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.*

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

Total Score: = 7

1. Pink Esthetic Score

Total = 4

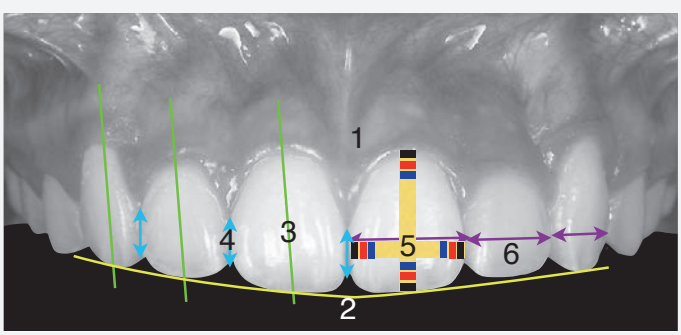


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

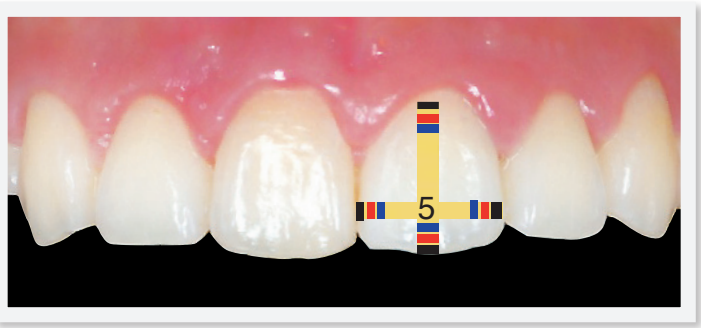
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	0	1	(2)
4. Level of Gingival Margin	0	1	(2)
5. Root Convexity (Torque)	0	1	(2)
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 3



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



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

International Beethoven Workshop

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2018 Session A: 05/22-25 (Full) Session B: 12/04-07

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3. Suture Techniques

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Day 2	Lecture, Model workshop, Chair-side observation
Day 3	VISTA Lecture, Lecture by Dr. John Lin, VISTA workshop
Day 4	Keynote workshop

KEYNOTE

Dr. Rungsi Thavarungkul, Thailand
Lecturer, Advanced Keynote Workshop

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THE LECTURERS

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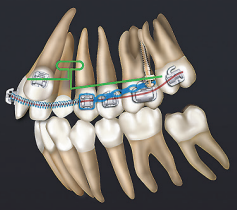

Topics:

1. Design illustration in Keynote.
2. Showcase your own drawing with stunning animation in Keynote.
3. Animation composition.

Lecturer:
Dr. Rungsi Thavarungkul,
Thailand

Early Bird

by 2017/10/02

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Requirements: Mac computer with OSX 10.11.X; Keynote 6.X (the latest)

Hu-Friedy
How the best perform

2017.7.23 (SUN.)

手持牙周器械操作成功的關鍵

KEYS TO SUCCESSFUL HAND INSTRUMENTATION

講師介紹

Nancy K. Mann, RDH, MS Ed.

Nancy K. Mann is a clinical professor of dental hygiene at Indiana University- Purdue University Fort Wayne, Indiana. She is a graduate of East Tennessee State University, Loyola University of Chicago, and Indiana University. Ms. Mann has lived abroad and taught internationally, including South Korea. Currently she is the Clinic II coordinator and teaches periodontics as well as periodontal instrumentation. She has consulted internationally on dental hygiene curriculum and program competencies and has authored textbook chapters as well as peer reviewed articles. She is certified in local anesthesia and tobacco cessation.

很榮幸今年 Hu-Friedy 原廠特地從 Indiana University- Purdue University 邀請來這位享譽全球的 Nancy K. Mann 教授，和大家分享《手持牙周器械操作成功的關鍵》。她是 Hu-Friedy 之御用講師，據說其獨特的演講魅力，使得看似簡單的器械使用，也變得極其生動且具啟發性！或許您會懷疑， 一個口腔衛生師觀點的演講真的對牙醫師來說受用嗎？根據 Hu-Friedy 在其他國家的經驗，這個答案是 yes！在其他國家，許多醫師聽完 Nancy K. Mann 教授的課，才發現其實魔鬼就藏在細節裡。

在美國口腔衛生師包辦了牙周治療的前段工作-檢查及牙周健康維護，Nancy K. Mann 擁有三十年以上的演講及臨床經驗，此次她將以互動及現場示範的方式，與台灣牙醫師們討論牙周器械的設計、建議使用方法與修磨等議題。每個品牌之器械製造理念及工法設計皆不同，好的器械若是忽略了正確的使用及修磨，而減少了器械的壽命，實在可惜！很基礎但卻非常重要的《手持牙周器械操作成功的關鍵》，從未在台舉辦過的演講內容，您一定要來參加！

SUBJECTS：

- Instrumentation, Ergonomics, Chairside Efficiency
- Instrument Sharpening
- Biofilm
- Mouth Body Systemic Connection
- Prevention
- Periodontics

課程時程表

08:30~09:00 - Registration
09:00~10:30 - Lecture
Key1: Choices we have for clinical
Key2: Biofilm Management
10:30~10:45 - Break
10:45~12:00 - Lecture
Key3: Assessment:Probing and Exploring
Key4: Choosing appropriate hand scalers
12:00~13:00 - Lunch
13:00~15:00 - Lecture
Key5: Re-evaluating the patient for treatment plan update
Key6: Sharpening; work smarter not harder
15:00~15:15 - Break
15:15~16:00 - Open discussion with Educators on Clinical Periodontics instruction, Q&A

課程資訊

主辦單位：湧傑企業股份有限公司
協辦單位：臺灣牙周病醫學會
時　　間：2017 / **07 / 23** (Sun.) 9:00~16:00
地　　點：集思北科大會議中心 感恩廳
台北科技大學(億光大樓)2樓
台北市忠孝東路三段197號旁
費　　用：
・**7/14前報名**：主協辦單位會員 1000元，非會員2000元
・**7/14後報名**：主協辦單位會員 2000元，非會員3000元
(臺灣牙周病醫學會專科訓練機構受訓醫師，可免費向湧傑報名)

備　　註：活動備茶點及午餐，素食請先告知。
報名未出席者恕不退還既收款項。

報名專線：02-27788315 分機#124王小姐 #125楊小姐
請於報名後三日內，至郵局劃撥費用
(於通訊欄註明報名場次)
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湧　傑 YONG CHIEH

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Comparison of the Failure Rate for Infra-Zygomatic Bone Screws Placed in Movable Mucosa or Attached Gingiva

Abstract

Objective: *Compare the six-month failure rates for infra-zygomatic crest (IZC) bone screws inserted into movable mucosa (MM) or attached gingiva (AG). The hypothesis was that MM would have a higher failure rate than AG.*

Materials and Methods: *A total of 386 patients (76 males and 310 females; mean age, 24.3 years; aged from 10 to 59 y/o) were treated with a 2x12mm IZC OBS (OrthoBoneScrew® Newton's A Ltd, Hsinchu City, Taiwan), bilaterally. Pairs of stainless steel (SS) and Ti alloy (TA) screws were randomly assigned as to side. All OBSs were positioned in the lateral aspect of the alveolar process, buccal to the upper first and second molar roots, by the same clinician (C.C.). All OBSs were placed at an angle of about 70 degrees above the horizontal (extra-alveolar approach) to achieve maximum bone engagement. Screw heads were positioned at least 5mm above the level of the soft tissue to facilitate oral hygiene. All OBSs were immediately loaded with pre-stretched elastomeric modules ranging from 8-oz to 14-oz (227–397 g or 223–389 cN), according to the patients' age and bone density. The clinician decided on the applied load according to clinical requirements, and the perception of the bone mass and density supporting the OBS. Six months after each screw was placed, it was routinely evaluated for mobility, ability to maintain continuous anchorage during the 6 month period, and type of mucosa penetrated by the tip of the OBS as it was installed. All 772 consecutively placed IZC OBSs in 386 patients were assessed for the soft tissue effect. SS vs. TA failure rate will be reported separately.*

Results: *387 were placed in MM and 385 were in AG. 49 out of 772 miniscrews failed (6.35%), 25 of which were in MM (6.46%), and 24 were in AG (6.23%); there was no statistically significant difference at the p<.05 level. There was no significant relationship between failure and the initial applied load. Failures were unilateral in 21 patients and bilateral in 14 patients. The failure rate on the right side (6.48%) was slightly higher than the left (6.22%), but the difference was not statistically significant. Patients with screw failures were 12-43 yr old, mean age of 24.2 yr, which was insignificant compared to the demographics of the entire sample.*

Conclusion: *IZC miniscrews were highly successful (93.65%), and there was no significant difference between MM and AG, or any other variable tested, i.e. age, side, asymmetry or initial applied load. (Int J Orthod Implantol 2017;47:96-106)*

Key words:
Infra-zygomatic crest, bone screws, skeletal anchorage, movable mucosa, attached gingiva, extra-alveolar orthodontic anchorage

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Editor-in-chief, International Journal of Orthodontics & Implantology (Right)

Introduction

Anchorage is one of the most important factors in orthodontic treatment. It is usually provided intraorally by other teeth or extraorally by headgear fitted to the head or neck.[1-3] Skeletal anchorage is provided by temporary anchorage devices (*TADs*): miniscrews[4] or osseointegrated implants.[5,6] Miniscrew anchorage was introduced in 1997 by Kanomi,[7] and gained wide acceptance in the orthodontic profession, particularly as more refined miniscrews were developed.[4,8] Miniscrews in interradicular and other intraoral sites provide anchorage for dental retraction, protraction, intrusion, and extrusion, for both erupted and impacted teeth.[9] Miniscrews have long suffered from a high failure particularly when they contact the periodontal ligament (*PDL*) adjacent to the roots of teeth.[10]

The infrazygomatic crest (*IZC*) is effective anchorage for many types of tooth movement including retraction of the entire upper dentition to correct Class II malocclusion,[11] excessive gingival exposure,[12]

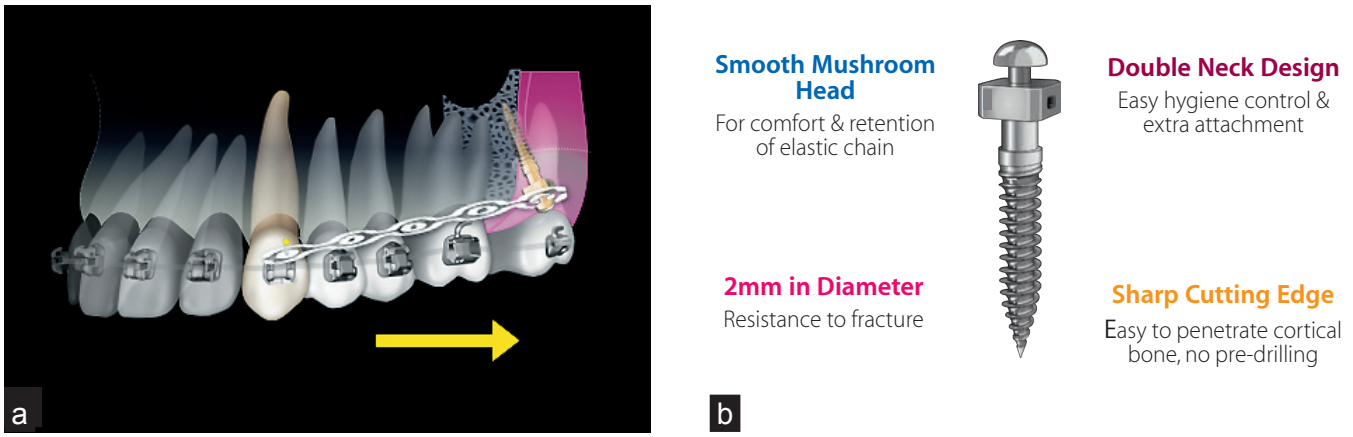

Fig. 1:
a. *The IZC bone screw mechanism that anchors the retraction of the entire maxillary arch (arrow) is illustrated by Dr. Rungsi Thavarungkul.*
b. *Specifications are shown for the 2x12mm SS bone screw designed to be inserted in the infra-zygomatic crest (IZC) as a self-drilling fixture.*

skeletal asymmetry,[13] maxillary canine-lateral incisor transposition,[14] and scissors bite.[15] It is vital to understand the failure rate of this relatively new method, relative to the type of soft tissue penetrated, age at failure, and initial applied load.

The primary aim of this research is to compare the failure rates of IZC screws inserted through movable mucosal (*MM*) as opposed to attached gingiva (*AG*). The hypothesis tested is that miniscrews placed in movable mucosa will have a higher failure rate (*<6 months*).

Material and Methods

The devices tested were 2x12mm stainless steel (*SS*) and Ti alloy ortho-bone-screws (*OBSs*) (*OrthoBoneScrew®, Newton's A Ltd, Hsinchu City, Taiwan*) randomly inserted according to side into the infra-zygomatic crest (*IZC*). A total of 772 IZC OBSs were placed bilaterally in 386 consecutive patients (*76 males and 310 females; mean age, 24.3 years*). All the screws were placed by the same orthodontist (*C.C.*) in the lateral aspect of the alveolar process, and buccal to the upper first and second molar roots. To permit efficient oral hygiene, all screw heads were at least 5mm superior to the soft tissue surface (*Fig. 2*).

There was a slight statistically significant, but clinically insignificant, difference in the failure rate (*<1%*) between SS and Ti alloy screws, that will be reported separately. The small overall number of failures (*<7%*) showed no significant relationship between the material and soft tissue site. The purpose for this report is to assess the effect of the soft site for all IZC bone screws (*n=772*) to compare to previous studies of mucosa effects. This research was conducted under Indiana University IRB Approval No. 1607517021.

Mucogingival junction (*MGJ*) was demarcated visually, and by manually moving the buccal mucosa. This method was previously shown to be as reliable as the Lugol's iodine technique.[16] Under local

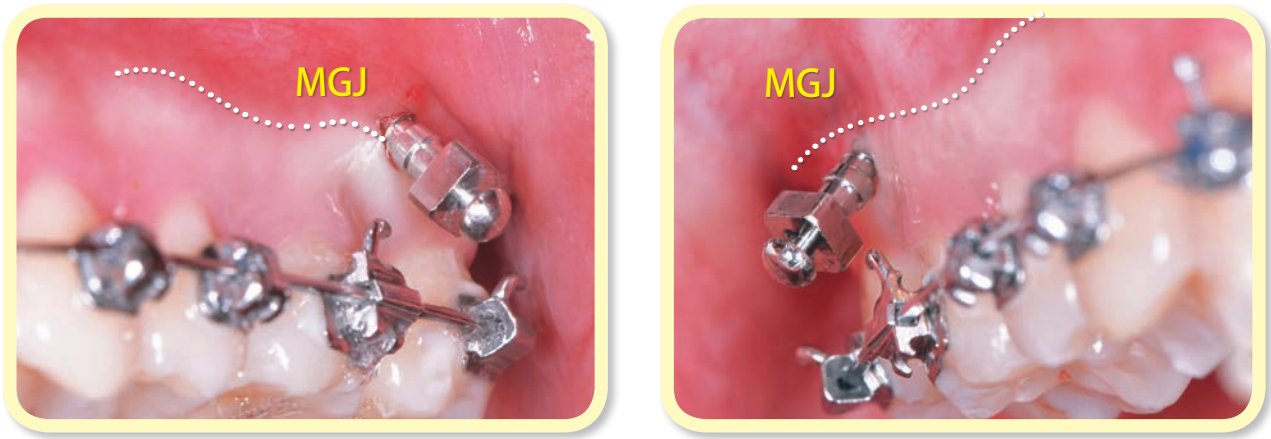

Fig. 2:
IZC OBSs placed in movable mucosa (left) and in attached gingiva (right). The white broken line is the mucogingival junction (MGJ).

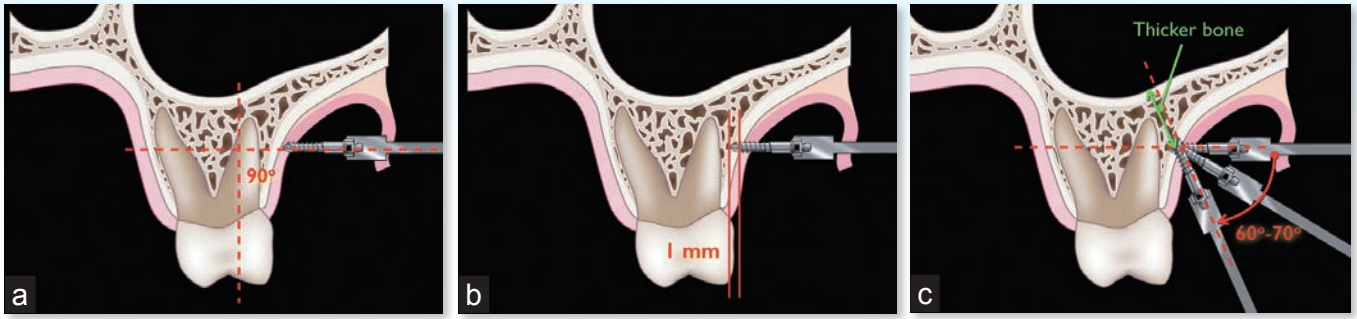

Fig. 3: A 2x12mm IZC bone screw is inserted, as illustrated by Dr. Runsi Thavarungkul:

a. Initial insertion of the screw tip is perpendicular (90°) to the bone surface.

b. The screw tip engages and penetrates an ~1mm bone cortex, buccal to the molar roots.

c. After the OBS penetrates the outer layer of cortical bone, the screw driver is turned clockwise, while rotating the angle of the screw about 60-70° in the frontal plane. This procedure achieves engagement of a thicker layer of bone at the base of the zygomatic process while avoiding the roots of the maxillary molars.

anesthesia, a sharp dental explorer was sounded through the soft tissue to mark the desired skeletal site for the bone screw without regard to the type of soft tissue at the site. No pilot drill or water cooling was needed. A self-drilling OBS was inserted into the wound and screwed into the bone perpendicular to the long axis of the adjacent teeth (*Fig. 3a*). After penetrating the cortical bone about 1mm (*Fig. 3b*), the driver was progressively rotated about 60°-70° to the occlusal plane to install the OBS in the thickest bone on the buccal surface of the maxillary molars (*Fig. 3c*). This method results in extra-alveolar (*E-A*) TADs that provide bilateral osseous anchorage in the posterior maxillary arch.[11-14] The final position of the screw head was just apical to the brackets on the molars (*Figs. 3-5*). Each OBS was immediately loaded from 8-14oz (*227g–397g or 223–389cN*), as needed relative to the bone mass and density supporting the OBS, as perceived by the clinician during the installation procedure. Pre-stretched elastomeric modules[17-19] were attached between the canine hook and the screw head to provide continuous anchorage for at least 6 months to retract the maxillary buccal segments. The installation protocol, and hygiene instruction to prevent soft tissue inflammation, were the same for all OBSs.

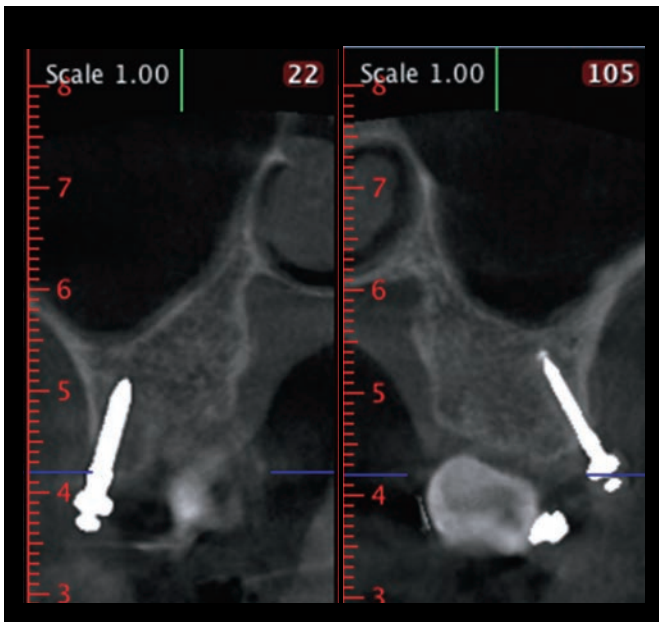

Fig. 4:

CBCT was taken after miniscrew insertion to make sure that the OBS is buccal to the molar roots, and to confirm that there is no root damage.

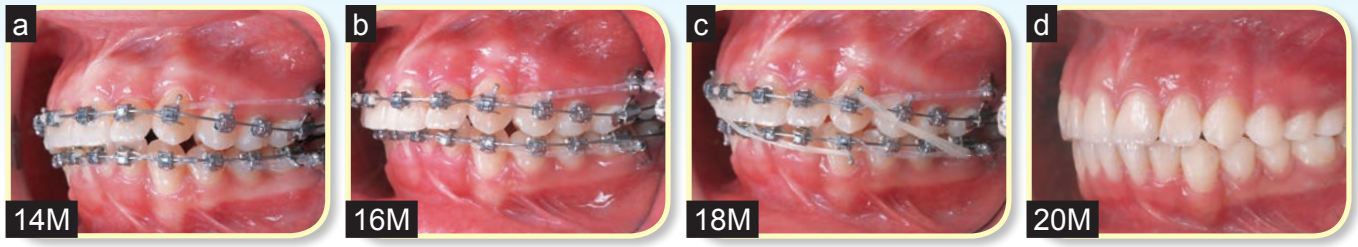

Fig. 5:

a. Correction of Class II occlusion with IZC anchorage commenced at 14 months (14M) into treatment.

b. As shown at 16 months (16M) most of the correction was achieved with an elastomeric chain anchored by the IZC OBS, and attached to the maxillary canines bilaterally.

c. A Class II elastic was initiated at 18 months (18M) to supplement the IZC anchorage.

d. At 20 months (20M) the correction was complete and the fixed appliances were removed. Note the entire Class II correction was achieved in 6 months.

Pre-stretched power chains were replaced bilaterally every 4 weeks, and the stability of the IZC screws was tested. The 6 month test duration was selected for all IZC OBSs because that period of maxillary retraction is adequate for most Class II patients to achieve an acceptable occlusion and facial profile.

Results

All 772 OBSs placed bilaterally in 386 consecutive patients were carefully assessed every 4 weeks for the first six months of maxillary arch retraction. Depending on the position of the OBS tip at the time of installation, 387 bone screws were placed entirely or partially in MM (*scored as MM*), and 385 miniscrews were surrounded entirely by AG. Failure was defined as loose screws that exfoliated spontaneously or were removed by the clinician within 6 months of installation. Failure incidences were: 1. 49 of 772 (*6.35%*) overall, 25 of 387 (*6.46%*) for the MM group, and 3. 24 out of 385 (*6.23%*) for the AG group (*Fig. 6*). A Chi-square test showed there was no statistical significance between the failure rates between the two groups (*MM vs. AG*) so the hypothesis was rejected.

About 94% of the patients were anatomically symmetrical, so the OBS were in the same type of

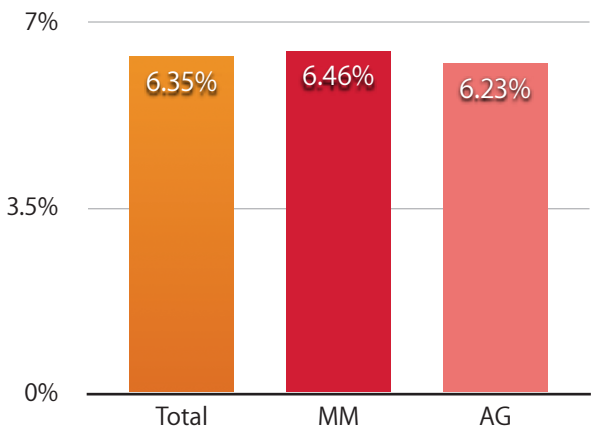

Fig. 6:

Overall IZC OBS failure rate was 6.35% (total). There was slightly higher tendency for screws to fail in MM compared to AG, but the difference was not statistically significant.

mucosa on both sides. However, there were ~6% asymmetric patients (*23/386*), so one bone screw was in MM and the other was in AG. 3 of 23 asymmetric OBSs failed (*~13%*) when placed in MM, and 2 of 23 (*~8.7%*) failed in AG. This difference was not statistically significant because of the small sample sizes.

The average time to failure for the 49 failed IZC bone screws was 3.3 months. The average age of the patient at screw failure was 24.2 years (*Fig. 7*), compared to 24.3 years, the overall age of the entire sample (*n=386*). Out of 49 failures overall, the number of left side failures was 24, and right side failures was 25. There was no significant statistical relationship between the failure rate compared to age, left side or right side. However, there was an interesting difference in unilateral compared to bilateral failure. The 49 failed screws came from 35 patients; 21 individuals had a single screw failure and the other 14 lost screws on both sides.

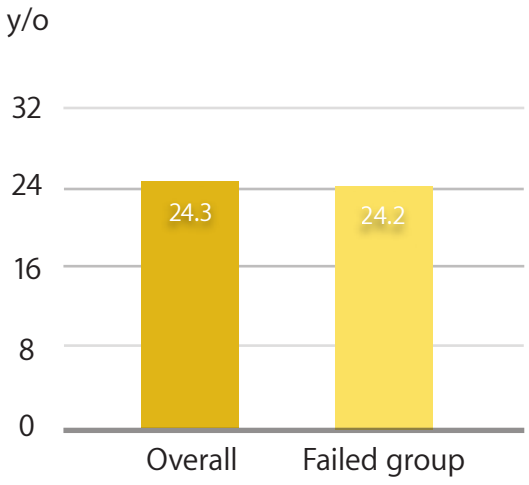

Fig. 7:
The age of patents for the overall sample (24.3yr) and the failure group (24.2yr) were nearly identical; there was no statistically significant difference.

Discussion

All 772 SS bone screws were installed without fracture, and no root damage was noted for any adjacent teeth. The successful TADs (*>93%*) provided continuous anchorage throughout the study. All screws that failed were replaced with another IZC OBS in a nearby site, as needed. Thus, E-A IZC bone screws were successful anchorage for all patients, but it was necessary to replace the screws that failed. These highly predictable devices have a failure rate of only 6.35% and almost all patients have suitable sites for placement. The present data demonstrate that IZC OBSs are an important advance in E-A osseous anchorage to support orthodontics and dentofacial orthopedics therapy. There are many important advantages compared to inter-radicular (*I-R*) miniscrews:

1. Less risk of tooth root damage
2. More abundant bone at the site of placement permits a larger screw diameter (*2mm*)
3. No interference with the path of tooth movement
4. Adequate anchorage for retracting the entire arch to reduce protrusion
5. Much lower failure rate
6. Fewer TADs are needed for comprehensive treatment of severe malocclusions

Clinical evaluation of I-R miniscrews has demonstrated that placing TADs in movable mucosa was problematic because of soft tissue irritation, inflammation, hyperplasia, and miniscrew loosening.[20] In addition, placing more than one I-R miniscrew reduces the chance of success by 67%.[20] The current study of 772 consecutive IZC bone screws in 386 patients documented bilateral failure in only 14 patients (*3.6%*).[21] A previous study of mandibular buccal shelf (*MBS*) bone screws documented a bilateral failure rate of only 16 of 840 (*1.9%*). Collectively, these data are more consistent with a genetic predisposition to OBS failure in a small fraction of patients[21] rather than a failure effect related to the number of TADs used per patient.[20]

Recent data reveal major advantages E-A compared to I-R TADs. The relatively low failure rate for IZC bone screws (*6.35%*), with no difference for MM or AG sites, is similar to outcomes for a larger study of 1680 consecutive MBS bone screws.[21] For the latter, there was an overall failure rate of 7.2%, but no significant difference for bone screws placed in MM (*7.31%*) or AG (*7.2%*). Thus, OBSs are equally reliable (*~93% or greater*) when placed in MM or AG at either the IZC or MBS sites. Attached gingiva in maxillary molar area is only 4mm wide on average[22] (*Fig. 9*), and the MM apical to the MGJ is what Sebastian and Terri[23] call the "*zone of opportunity*." Mucosa becomes firmly attached to the periosteum at the MGJ, and there is virtually no mobility, relative to underlying bone, so MM is an ideal site for I-R mini-implant or miniscrew insertion.[20,23] Since recent studies have noted that cortical bone thickness increases in the apical direction,[24-26] the MM apical to the MGJ offers TAD sites with more space between the conical dental roots because they usually diverge in an apical direction. Anatomically more apical positioning of the I-R miniscrew sites reduces the risk of root contact, a common factor in mini-

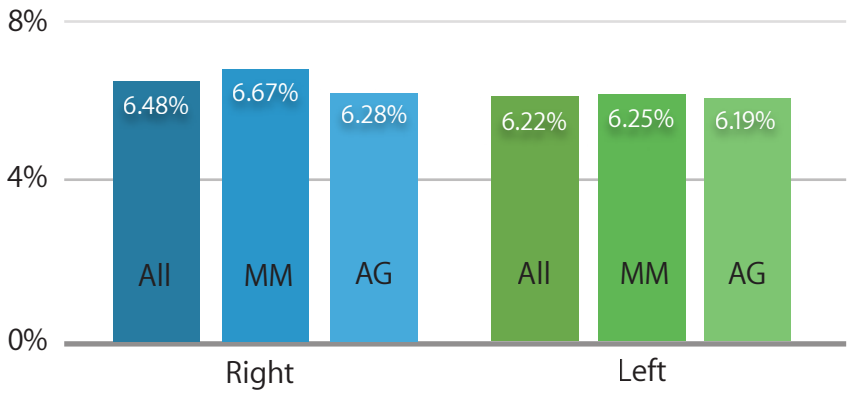

Fig. 8:
There was a slightly higher tendency for failure on the right compared to the left side, and MM failure was slightly elevated in both groups, but none of the differences were statistically significant between or within the groups.

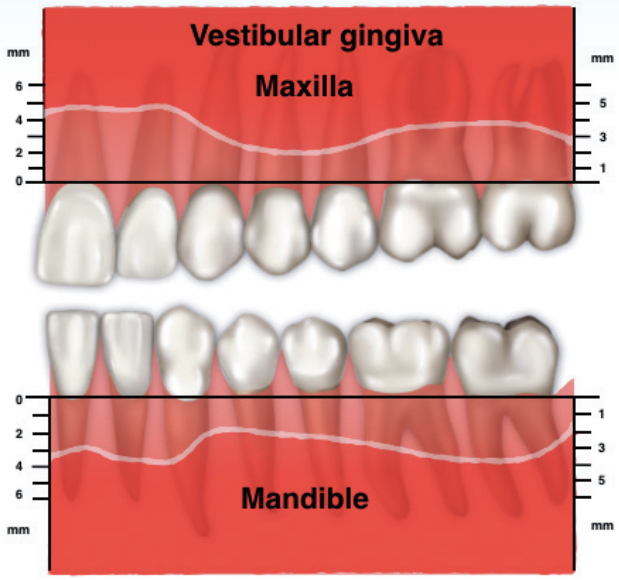

Fig. 9:
The average width of attached gingiva on buccal side is illustrated for the maxillary and mandibular arches. Adapted from Clinical Periodontology and Implant Dentistry 2008, Reference 22.

implant failure,[10,27,28] but the MM covering the more apical sites is a higher risk site for I-R TADs. Mucosa covering is not a significant risk factor for OBSs, which is a major advantage for E-A TADs in the IZC (*Fig. 6*) or MBS sites.[21]

Some patients with excellent AG width for OBS placement had exostosis (*Fig. 10*). The large mass of bone buccal to the molars was covered wth AG, which was convenient for IZC bone screw placement, but the internal bone density was poor. To engage as much bone as possible, the OBSs were screwed in deeper than 5mm relative to the soft tissue surface. Soft tissue irritation was not a problem despite the screw platform being near the mucosa, probably because it was easier to keep the OBSs on exostoses clean compared to sites closer to the molars (*Fig. 10*).

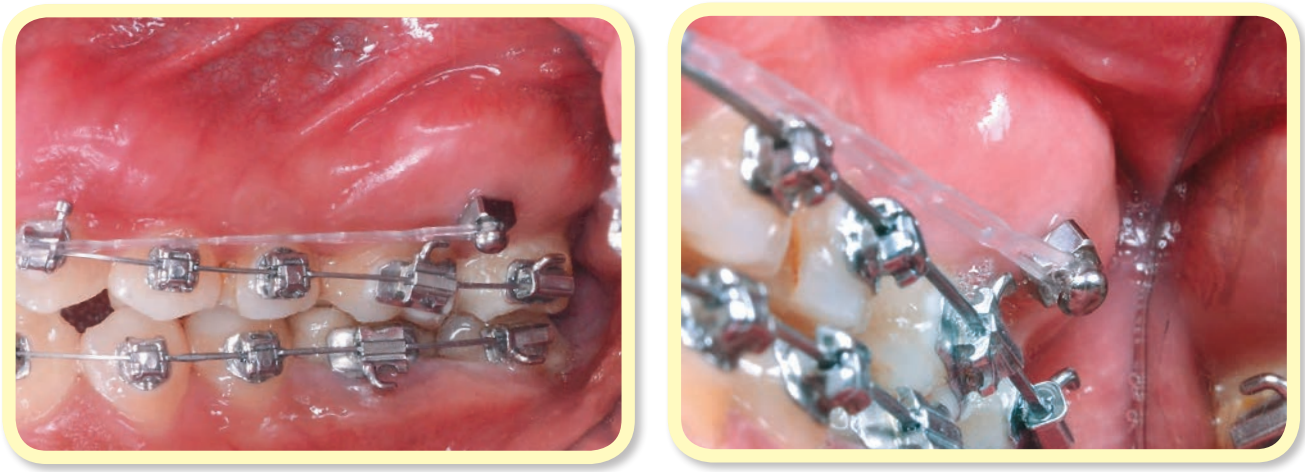

Fig. 10:
Some patients in the sample had exostoses on the buccal surface of the maxillary molars that were covered with attached gingiva. See text for details.

The failure rates for many types of I-R miniscrews are relatively high, so many authors report the clinical experience as a "*success rate*" from 57-95%, with an average of about 84%.[29-31] The failure rate for the current E-A bone screws in the IZC area based was 6.35%, which is comparable to MBS OBSs (*7.2%*),[21] but is considerably less for I-R miniscrews in the mandible (*19.3%*) or the maxilla (*12.0%*).[32,33]

Within the restraints of this study, the failure rates (*Fig. 6*) of IZC bone screws in either MM (*6.46%*) or AG (*6.23%*) are the lowest rates for non-integrated TAD failure reported for any large patient sample (*≥50*). The consecutive patient sample size (*n=386*) is only exceeded by a study of MBS OBSs (*n=1680*) in 840 consecutive patients.[21] It is clear that E-A OBSs inserted in the buccal surface of either the posterior mandible (*MBS*) or the posterior maxilla (*IZC*) are the most reliable TADs currently available for orthodontic anchorage.

Furthermore, E-A OBSs offer new horizons for dentofacial orthopedics because the location of the TADs, buccal to the roots of the molars, is advantageous for moving the entire dental arch relative to the apical base of bone with determinate mechanics.[34] Thus, conservative dentofacial orthopedics, with no extractions or orthognathic surgery, is capable of managing severe skeletal malocclusions by moving entire arches as segments. Modest bilateral forces of 200cN, applied to an entire arch as a segment, results in relatively uniform PDL stress below the necrotic threshold. Avoiding PDL necrosis enhances the rate of tooth movement and reduces the risk of root resorption.[35-36]

The excellent success with E-A bone screw anchorage in the IZC (*Figs. 6-8*) and in the MBS has considerably expanded the therapeutic scope for conservative treatment of severe skeletal malocclusion: Class II[37,38] and Class III.[39] These E-A devices have also provided effective anchorage to manage vertical dimension problems in the maxilla[40] and mandible.[41] In addition, E-A anchorage in the posterior aspect of the arch is advantageous for severe dentoalveolar crowding.[37,42] CBCT imaging is not essential for utilizing OBSs, but the 3D image is useful for confirming the buccal clearance of the screws relative to the adjacent molar roots.[43]

Conclusions

1. E-A bone screws placed in the IZC have a low failure rate (*6.35%*) over 6 months, and there is no statistically significant difference for sites covered with movable mucosa or attached gingiva.

2. The 2mm diameter bone screws placed in the IZC were not susceptible to fracture, and they offer distinct advantages compared to miniscrews placed near the roots of teeth: lower failure rate, no interference with the path of tooth movement. Furthermore, they offer adequate anchorage to retract the entire maxillary arch, retract molars for non-extraction alignment of a crowded dentition, and present less potential for root damage.

3. E-A bone screws placed buccal to the molars in both arches have ~93% success rate. OBS skeletal anchorage lateral to the dental arches has proven effective for conservative management of many severe skeletal and dental malocclusions.

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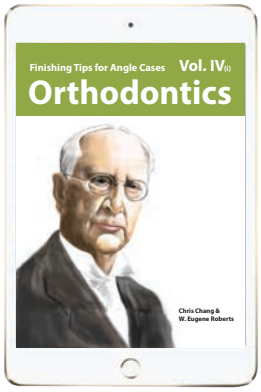

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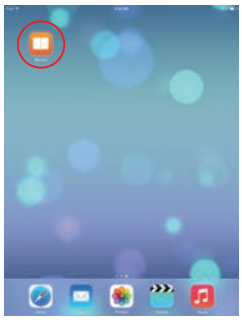

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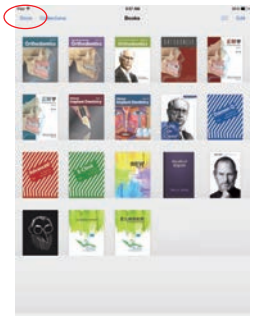
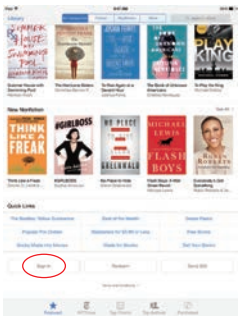
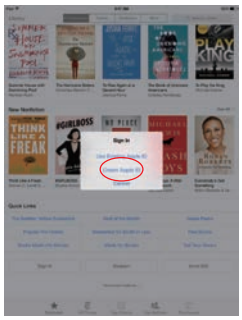


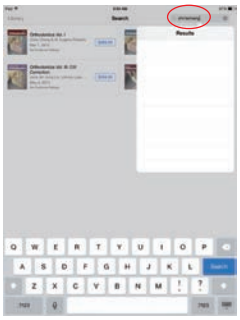
2. Click "Store."



3. "Sign in" with your Apple ID.



4. "Create Apple ID" if you don't have one.



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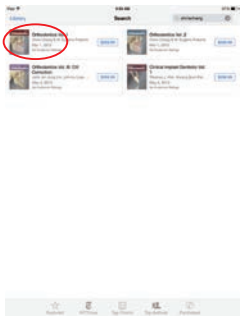

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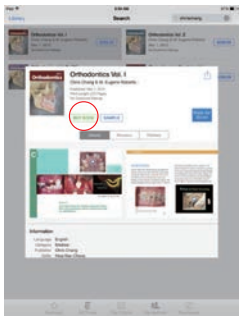

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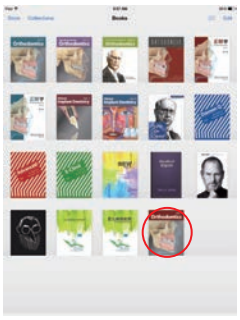

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Rebonding Tips for the Custom Bracket System: Insignia®

Abstract

Bracket-positioning jigs are crucial for guiding precise, indirect bonding of Insignia® brackets. There are three tips to successfully rebond the Insignia® brackets with proper application of jigs and brackets.

***Tip 1**: Carefully check residual resin on the bracket base and the tooth surface. Identify potential dislodgement factors and eliminate them.*

***Tip 2**: Use a customized single jig, not the group jig, to precisely position the bracket on the tooth surface.*

***Tip 3**: Before setting resin with light-curing, press down the corner of jig with a finger and ensure the bracket base securely fitted onto the tooth surface with the tip of a scaler or explorer. (Int J Orthod Implantol 2017;47:110-113)*

Key words:
Insignia® system, passive self-ligating bracket, custom bracket, indirect bonding, bracket-positioning jig

Introduction

Insignia® (*Ormco, Glendora, CA*), is a customized, digitally reverse-engineered appliance with built-in tipping, rotation, and torque values. Compared to conventional direct bonding brackets, Insignia® is an indirect bonding bracket using bracket-positioning jigs for precise bonding which is key to the effectiveness of Insignia custom brackets.

Rebonding is required sometimes during treatment as the brackets may become loose. Precise rebonding the brackets to their designed positions is extremely important, and easy to achieved by following these three tips.

Tip 1: Check residual resin

The causes of bracket dislodgement vary and primarily involve brackets and/or tooth surface. Depending on the quantity of residual resin left on the bracket base versus the tooth surface, corresponding contributing factors and solutions are proposed below.

Dr. Charlene Chang,
Lecturer, Beethoven Orthodontic Center, Hsinchu, Taiwan (Left)
Dr. Angle Lee,
Director, Beethoven Orthodontic Center, Hsinchu, Taiwan
Editor, International Journal of Orthodontics & Implantology (Center Left)
Dr. Chris Chang,
Founder and president, Beethoven Orthodontic Center, Hsinchu, Taiwan
Publisher, International Journal of Orthodontics & Implantology (Center Right)
Dr. W. Eugene Roberts,
Editor-in-chief, International Journal of Orthodontics & Implantology (Right)

(A) All residual resin on the bracket base (Fig. 1a)

Dislodgement factor: Contamination of tooth surface–plaque deposits and/or insufficient preparation of etching and bonding agents.

Solution: Clean the tooth surface thoroughly. Apply the etching and bonding agent following the manufacturer's instructions.

(B) All residual resin on the tooth surface / 0% residual resin on the bracket base (Fig. 1b)

Dislodgement factor: Contamination of the bracket base, and/or worn and shallow meshes.

Solution: Clean and dry the bracket base completely. Replace the bracket if the base is too smooth by checking with a sharp instrument.

(C) 50% residual resin on the bracket base and 50% on the tooth surface (Fig. 1c)

Dislodgement: Excessive occlusion.

Solution: Apply bite turbos to increase the vertical dimension of occlusion (*VDO*).

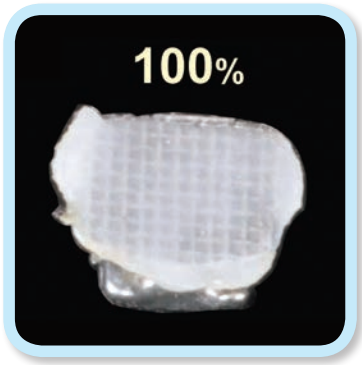

Fig. 1a: 100% residual resins left on the bracket base

Fig. 1b: 0% residual resin left on the bracket base

Fig. 1c: 50% residual resin left on the bracket base

Tip 2: Use a single jig

Insignia® provides group jigs to initially position the brackets (*Fig. 2a*). In addition to the group jigs, a single jig is prepared for each tooth (*Fig. 2b*). The single jig's inner-face is designed with a more detailed map than the group jig, which provides more stability and retention when fitting it on the tooth (*Fig. 2c*).

Fig. 2a: Group jigs for initial brackets positioning

Fig. 2b: Single jigs for bracket rebonding

Fig. 2c:
Yellow lines on the jigs present 3D-printed maps to fit onto the occlusal surface. The single jig's inner-face (left) contains a more detailed map than the group jig (right), which provides more stability and retention on the tooth.

Tip 3: Press to fit

After accurately positioning an Insignia® bracket with an single jig, press down the corner of the jig with a finger for stability. Before setting the resin with light-curing, reaffirm the bracket base fitted with the tooth surface with a scaler or explorer (*Fig. 3*).

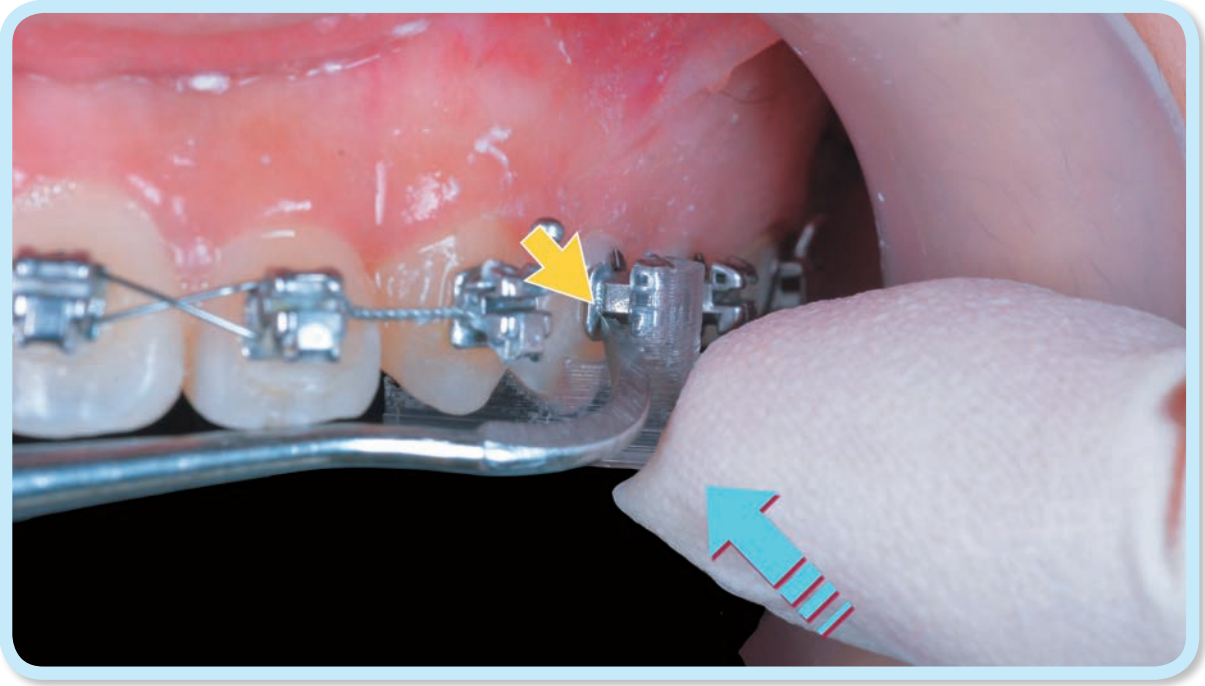

Fig. 3: After pressing down the corner of the jig with a finger (blue arrow), use a scaler to secure the bracket base (yellow arrow).

Conclusion

After checking the residual resin, and pressing down the single jig and bracket to fit, it is easy to confidently rebond the Insignia® custom bracket to its designed position.

2017~2018 第九年度

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No.	日期 (W2)	精選 文獻分析 09:00 ~ 10:00	精緻完工案例 10:00 ~ 10:30	臨床技巧及常犯錯誤分享 10:50 ~ 11:50
89	8/15	**Absence of multiple premolars and ankylosis of deciduous molar with cant of the occlusal plane treated using skeletal anchorage**	IAOI Finishing case 01	Clinical Tips 01
90	9/26	**Angle Class III malocclusion treated with mandibular first molar extractions**	IAOI Finishing case 02	Clinical Tips 02
91	10/17	**Esthetic evaluation of implants vs canine substitution in patients with congenitally missing maxillary lateral incisors: Are there any new insights?**	IAOI Finishing case 03	Clinical Tips 03
92	11/14	**Restoration of a vertical alveolar bone defect by orthodontic relocation of a mesially impacted mandibular first molar**	IAOI Finishing case 04	Clinical Tips 04
93	12/19	**Conservative treatment for a growing patient with a severe, developing skeletal Class III malocclusion and open bite**	IAOI Finishing case 05	Clinical Tips 05
94	2018 1/9	**Treatment of an impacted dilacerated maxillary central incisor**	IAOI Finishing case 06	Clinical Tips 06
95	3/6	**Asymmetric transverse control of maxillary dentition with two midpalatal orthodontic miniscrews**	IAOI Finishing case 07	Clinical Tips 07
96	4/10	**Orthodontic correction of a transposed maxillary canine and first premolar in the permanent dentition**	IAOI Finishing case 08	Clinical Tips 08
97	5/15	**Protraction of mandibular second and third molars into missing first molar spaces for a patient with an anterior open bite and anterior spacing**	IAOI Finishing case 09	Clinical Tips 09
98	6/26	**Treatment of unilateral posterior crossbite with facial asymmetry in a female patient with transverse discrepancy**	IAOI Finishing case 10	Clinical Tips 10
99	7/17	**Rescue therapy with orthodontic traction to manage severely impacted mandibular second molars and to restore an alveolar bone defect**	IAOI Finishing case 11	Clinical Tips 11

學習目的：

研讀經典文章可以窺知世界文獻公認的治療方式，而藉由評論文章的優缺點不僅能夠訓練判斷與思考能力，更可以清楚比較作法上的不同，達到完整理解治療方向、內容與穩定性的目標。

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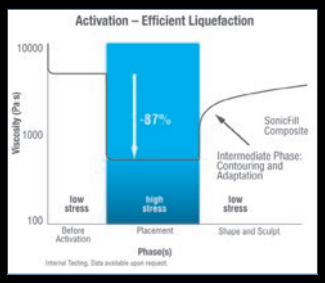

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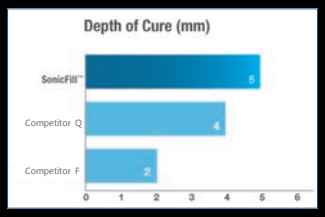

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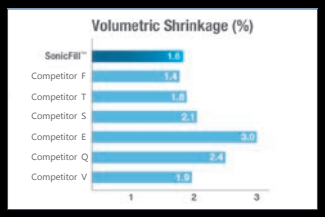
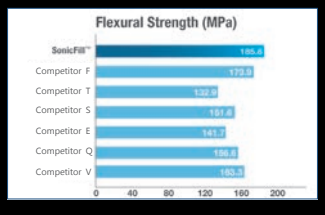


Low shrinkage



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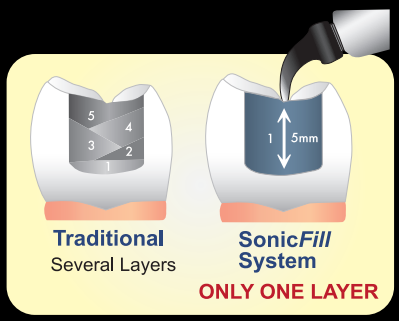

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Feedback from the 27th Beethoven International Workshop, May, 2017.

Dr. Christophe Bodart, France

For me, it was a challenge to place a IZC or BS screw. I needed to know more. Seeing and listening to Dr. Chris Chang's live lecture or chair-side explanation were very instructive, and there were more explanations when we saw his practice in live, as we were faced with different kinds of issues.

If we missed something, we can also resort to a lot of materials on Dr. Chang's Youtube channel, eBooks, e-learning materials… etc.

I'm so grateful to him and all of his staff for giving me the opportunity to benefit from his knowledge.

Dr. Nawal Al mutawa, Bahrain

The lectures, clinical, hands-on, and the Keynote workshop were all well arranged. They meet all of my current learning needs. Surely, I am coming back again to learn more.

It was amazing and very interesting that we could observe a lot of clinical cases, which covered different aspects. The staff were very helpful and well organized. It was pretty good.

I would like to thank Dr. Chris Chang for his generous teaching and hospitality, and all his team for the kind treatment.

I was highly impressed with lectures and the chair-side observation at Dr. Chang 's clinic. It's amazing to see "how he runs the show" with all the patients and staff.

It was really good. He showed in a very detailed way how to place the miniscrews and the biomechanics of how things work. This will definitively be a great tool for my practice.

And I loved that he placed a lot of screws during our observation session, so we could learn by repetition. Everything was fine. I loved the attention by Dr. Chang's wife too, she was great with all the group. And I would like to congratulate Bella and Chester also, they did a great job, too.

Dr. Leopoldo Vesco, Guatemala

Every bit of the course was brilliant. Thank you. Allowing participants to video record is much appreciated. It helps greatly when we return home. There is so much information to take in that is impossible to remember everything when in Taiwan, especially for those of us who are a little jet lagged!

Dr. Chris and his staff are so generous with their time and sharing their knowledge. You can read a book or watch a YouTube video which is great but there is no learning experience that compares to being chair side and learning from The Master and his staff. Keep up the great work! Thanks to everyone again. I hope to return to your practice at some time in the future. Sooner rather than later I hope.

Dr. Shane Curtin, Ireland

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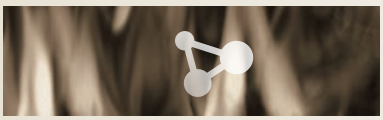

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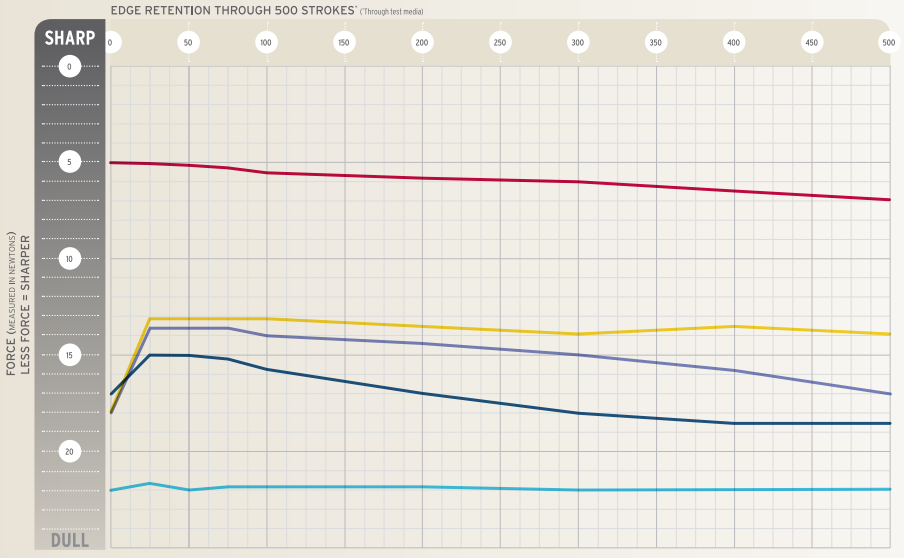

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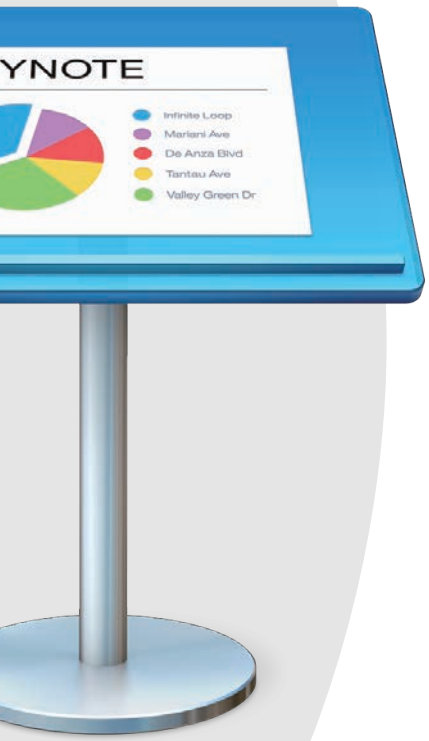

技巧班　強化你的 Keynote 簡報力

(四) 11/16

無論是 Keynote 新手或是略有經驗的使用者，在一天的簡報課程中，將精選介紹 Keynote 的重要工具，幫助你設計合適的動畫，分享設計資料視覺化的秘訣，並搭配 Mac 內建常用的影音工具來編修圖片和影像剪輯，金牛頓的教學團隊將教你如何使用 Keynote 創造出動人的專業簡報。

講師：金牛頓工程師

大師班　賈伯斯的簡報秘訣與設計要素

(四) 11/23

由國際知名的牙科講師張慧男醫師主講的一天課程，將以他幽默風趣的演講風格來剖析賈柏斯的美學概念以及演講秘訣，利用實例來說明如何設計出視覺優美且知識性豐富的專業演講。

講師：張慧男醫師

動畫班　精修繪圖及動畫技巧

(六~一) 12/2-4

數位化潮流下的牙科簡報，不僅需要清晰的臨床照片，也需要精確的圖表和流暢的動畫來吸引觀眾，而優秀的視覺化工具更使您的演講獨樹一格且令人難忘。

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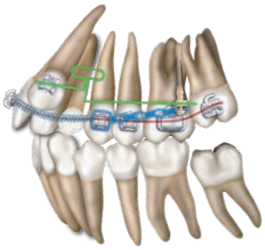
講師：Dr. Rungsi Thavarungkul



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This method of learning is quantum leap forward. My students at Oklahoma University will benefit greatly from Chris Chang's genius. *Dr. Mike Steffen, Oklahoma, USA*

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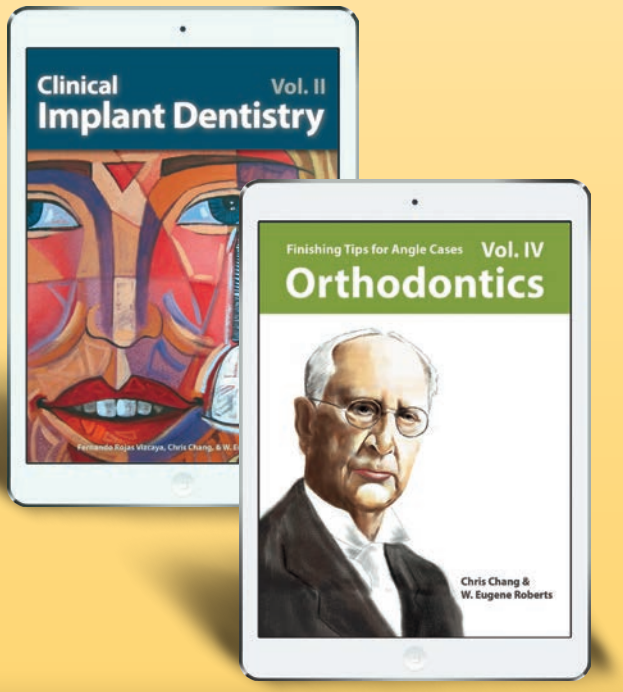
"Dr. Chang's technique is absolutely amazing and cutting-edge. Anybody who wants to be a top-tiered orthodontist MUST incorporate Dr. Chris Chang's technique into his/her practice." *Dr. Robert S Chen, California, USA*



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

Dr. Errol Yim, Hawaii, USA

"Beyond incredible! A more effective way of learning." *Dr. James Morrish Jr, Florida, USA*

The 27th Beethoven international workshop, May 16-18, 2017. Participants took photos with Drs. John Lin (first row, center right) and Chris Chang (first row, center left) in front of the Angle library in Newton's A, Hsinchu, Taiwan.

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