Asymmetric Class II Malocclusion Acquired from Early Loss of a LR6 and UL Primary Canine: Reverse the Etiology and Align a Horizontally Impacted LR8 with a Ramus Bone Screw

Abstract

***Introduction**: A 26 yr female presented with a chief complaint of "missing and crooked teeth."*

***Diagnosis**: Compensated Class II, division 2 malocclusion was complicated with severe crowding, reduced axial inclination of upper and lower incisors, decreased lip protrusion, blocked-in UL5, lingual crossbite LL7, missing LR6, and horizontally impacted LR8. The American Board of Orthodontics (ABO) Discrepancy Index (DI) was 24.*

***Etiology**: The cause of this severe acquired malocclusion was deemed premature loss of two teeth: LR6 due to Molar Incisor Hypomineralization (MIH), and UL deciduous canine due to UL2 ectopic eruption.*

***Treatment**: Reverse the maxillary portion of the etiology by opening space to align the UL5. Correct the mandibular discrepancy by moving the LR7 mesially, uprighting LR8 with ramus bone scarew (RBS) anchorage, and align the LR7 and LR8 in the LR6 and LR7 positions. Extract the UR8 and LL7, and then align the LL8 in the LL7 position. Active treatment time: 36 months.*

***Outcomes**: Facial, dental and smile esthetics were near ideal. Both arches were well aligned. The LR7 and LR8 were substituted into the first and second molar positions. Despite successful molar substitution, correction of incisal axial inclinations, and achieving excellent dentofacial esthetics, there was a residual Class II intermaxillary relationship. The Cast-Radiograph Evaluation (CRE) was 33, and the Pink & White dental esthetic score was 0.*

***Conclusion**: RBS anchorage is efficient mechanics for recovering a severe horizontal impaction in the posterior aspect of the mandibular arch. Substitution of a recovered impaction for a missing mandibular molar is a viable clinical option. However, uprighting and aligning impactions is a technique sensitive approach that requires careful planning and execution. (J Digital Orthod 2018;50:26-46)*

Key words:
Adult complex treatment, ramus bone screw, horizontal impaction, third molar, uprighting mechanics, molar substitution, space closure, midline correction, pegged lateral incisor, camouflage treatment, MIH

Mandibular first molars are usually the first permanent teeth to erupt and their development is frequently affected by Molar-Incisor Hypomineralization (*MIH*), a dental developmental disorder related to childhood illness and high fever prior to the age of 3 years.[1] Permanent teeth erupting during the early transitional dentition (*6-8yr*) are the most frequently affected. A defective molar is rarely noticed by the parents until there is a tooth ache, and then the hopelessly decayed tooth must be extracted, usually before the age of 8 years. The isolated loss of permanent first molars in the early transitional dentition (*6-8 years of age*) is pathognomonic for MIH, a worldwide problem affecting up to 20% of the population.[2] Occlusal development problems following the early loss of permanent first molars are a common etiology for acquired malocclusion in adolescents and adults.[3]

Dr. Chi Huang,
Resident, Beethoven Orthodontic Course
Editor, Journal of Digital Orthodontics (Left)

Dr. Bill Chuanwei Su,
Director, Newton Implant Center
Associate Editor, Journal of Digital Orthodontics (Center left)

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

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

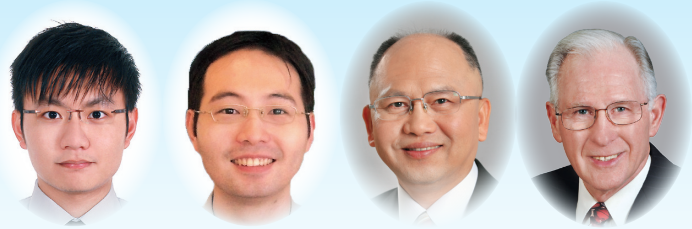


Fig. 1: Pre-treatment facial and intraoral photographs

Moving second and third molars mesially to close a missing first molar space is a relatively common procedure,[3,4] probably because of the high prevalence of MIH.[1-3] However, many third molars are bony impactions, so it was unclear if attempting to upright and align them was efficient clinical practice. Lin[5] reviewed six methods for molar uprighting and concluded that surgical exposure of deeply impacted molars, followed by traction with elastomeric chains anchored by RBS, was an efficient approach.[6] More recent studies have established the mandibular ramus bone screw (*RBS*) as reliable anchorage for uprighting deep horizontally-impacted lower third molars.[7] This novel approach for restoring function after the loss of a LR6 is documented by the present case report. RBS anchorage was utilized to upright a horizontally impacted lower third molar (*LR8*), that was subsequently aligned to help restore normal occlusal function. The current carefully documented case report focuses on treatment details and clinical insights.

Diagnosis and Etiology

A 26-year-old female presented for orthodontic evaluation of missing and malaligned teeth. Initial records (*Figs. 1-4*) documented a severe malocclusion. There was no contributory medical history, but the dental history revealed a lower permanent molar (*LR6*) was extracted during early childhood, so it was probably related to MIH.[1-3] The subsequent mesial migration of the LR7 may have contributed to the horizontal impaction of the LR8 (*Fig. 5*). There were no other problems reported that would negatively impact comprehensive orthodontic treatment.

Facial examination revealed a relatively symmetrical, square frontal morphology, but the oral commissure was canted superiorly on the left side (*Fig. 1*). Smile evaluation showed an inadequate smile arc (*Fig. 2*), a dark buccal corridor on the left side, and greater commissure elevation on the left compared to the right side (*Fig. 1*). Facial convexity (*13.5°*) was within normal limits (*WNL*), but both axial inclination of the upper and lower incisors (*88/81.5°*), as well as lip protrusion (*-4.5/-3.0mm to the E-line*) were decreased (*Table 1*). The lower dental midline was coincident with the facial midline, but the maxillary midline was deviated 3-4mm to the left (*Fig. 1*). These data are consistent with physiologic drift after the unilateral loss of the left upper primary canine, probably due to ectopic eruption of the permanent lateral incisor (*UL2*).

Pre-treatment cast evaluation showed a Class II Division 2 malocclusion (*Fig. 3*) with a blocked-in UL5, missing LR6, and peg-shaped maxillary lateral incisors (*Fig. 2*). There was >10mm of crowding in the upper arch and a 5mm space deficiency in the lower anterior region. The UL5 and LL7 were in lingual crossbite, and the overbite was 5mm. The LR6

Fig. 2: Smile evaluation

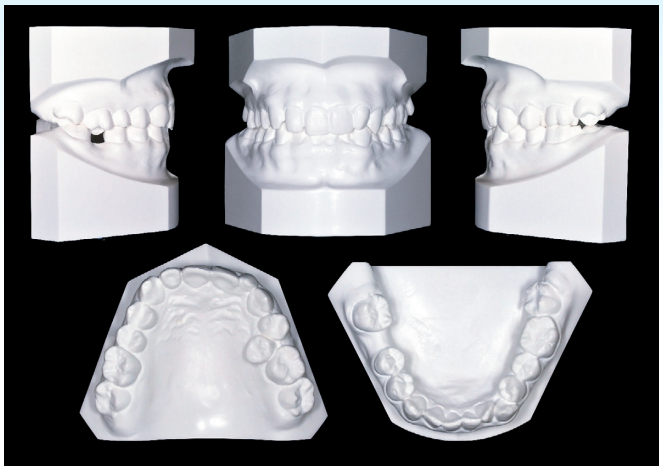


Fig. 3: Pre-treatment study models (casts)

Fig. 4: Pre-treatment cephalometric radiograph

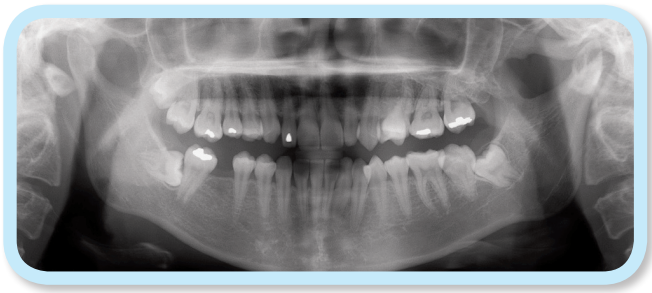


Fig. 5: Pre-treatment panoramic radiograph

extraction site was approximately 8mm in length, but the ridge width was judged to be inadequate for an implant without bone augmentation (*Figs. 1 and 3*).

The panoramic radiograph (*Fig. 5*) documented that the LR7 had drifted mesially into the missing LR6 space, and the LR8 was a deep horizontal impaction. On the left side, the LL8 was a mesioangular partial bony impaction. No significant periodontal bone defects were noted, and multiple amalgam restorations attest to a history of regular dental care (*Figs. 1 and 5*). There was no history of temporomandibular joint (*TMJ*) dysfunction, nor was a functional shift of the mandible detected in the closed or opened positions (*Fig. 6*). TMJ radiographic images with the mouth opened and closed were WNL (*Fig. 7*).

The pre-treatment cephalometric analysis revealed that the sagittal relationships of the maxilla (*SNA*) and mandible (*SNB*) are WNL, but there was a slightly elevated ANB of 3.5˚. The mandibular plane angle

Fig. 6:
A frontal open mouth photograph is used to determine if there is a functional shift of the mandible that contributes to the midline discrepancy. Note the asymmetry of the peg-shaped maxillary lateral incisors. See text for details.

(25.5˚) was WNL (*Fig. 4 & Table 1*). The American Board of Orthodontic (*ABO*) discrepancy index was 24 points, as shown in the supplementary worksheet 1.

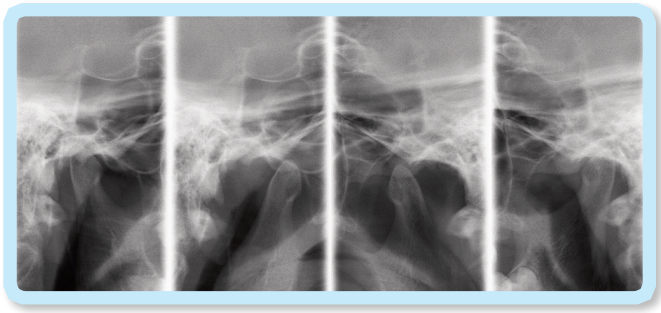


Fig. 7:
From left to right, pre-treatment temporomandibular joint (TMJ) transcranial radiographs are: R TMJ closed, R TMJ open, L TMJ open, and L TMJ closed.

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA˚ (82°)	82.5°	82.5°	0°
SNB˚ (80°)	79°	79°	0°
ANB˚ (2°)	3.5°	3.5°	0°
SN-MP˚ (32°)	32.5°	32.5°	0°
FMA˚ (25°)	25.5°	25.5°	0°
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	-2 mm	2 mm	4 mm
U1 To SN˚ (104°)	88°	105°	17°
L1 To NB mm (4 mm)	2 mm	4 mm	2 mm
L1 To MP˚ (90°)	81.5°	90°	8.5°
FACIAL ANALYSIS			
E-LINE UL (2-3 mm)	-4.5 mm	-4 mm	0.5 mm
E-LINE LL (1-2 mm)	-3 mm	-2 mm	1 mm
Convexity: G-Sn-Pg' (13°)	13.5°	13.5°	0°
%FH: Na-ANS-Gn (53)	53.3%	53.3%	0%

Table 1: Cephalometric summary

Treatment Objectives

1. Install a full fixed passive self-ligating (*PSL*) appliance.
2. Maintain the skeletal relationships of the maxilla and mandible in all three planes.
3. Correct the maxillary arch alignment by opening space for the blocked-in UL5.
4. Increase the axial inclination of the upper and lower incisors to correct lip retrusion.
5. Extract UR8 and LL7.
6. Upright the LR8 with RBS anchorage.
7. Move the LR7, LR8 and LL8 mesially to close edentulous spaces in the mandibular arch.
8. Detail and finish the occlusion with bracket repositioning, archwire adjustments and vertical elastics.

Treatment Alternatives

Extraction of the LL8 rather than the LL7 was an unfavorable option because the third molar roots were near the mandibular canal (*Fig. 5*), and surgery posed a risk of paraesthesia. Uprighting the LL7 would probably result in occlusal prematurities that would complicate and probably lengthen the treatment time. Furthermore, the LL7 root was conical, while the third molar root was divergent. Longterm periodontal prognosis for divergent roots is better than for conical roots.[8-10] Assuming the LL8

Fig. 8:
At three months (left), the peg-shaped maxillary lateral incisors were restored with composite resin, and the brackets were positioned more gingivally. At five months (right), the maxillary incisors are aligned on a straight archwire. See text for details.

was not ankylosed, the best option was extraction of the LL7 and orthodontic movement of the LL8 to substitute for the LL7. After discussing the pros and cons for each treatment option, the patient selected extraction of the LL7 and substitution with the LL8.

Treatment Progress

The patient preferred to initially pursue the esthetic goals in the maxillary arch, and delay the extractions and molar corrections until the end of treatment. A 0.022-in Damon Q® (*Ormco, Glendora, CA*) fixed appliance was installed. The mandibular anterior segment was bonded with normal torque brackets but the maxillary central incisors and canines were bonded with low torque brackets. The latter are preferred for managing severe crowding with a non-extraction treatment plan. The upper archwire sequence was: 0.014-in CuNiTi, 0.016-in CuNiTi, 0.014x0.025-in CuNiTi, 0.017x0.025-in TMA and 0.019x0.025-in SS. The corresponding lower arch sequence was 0.014-in CuNiTi, 0.018-in CuNiTi, 0.014x0.025-in CuNiTi, 0.017x0.025-in TMA and 0.016x0.025-in SS. Ni-Ti open coil springs were used to create space for the upper left peg lateral incisor, blocked-in upper left second premolar, and the severely rotated lower left lateral incisor.

In the first month of treatment, posterior bite turbos (*BTs*), made with Fuji® II type II glass ionomer cement (*GC America, Alsip IL*), were bonded on the occlusal surfaces of mandibular molars. The BTs opened the bite and prevented occlusal interference that might break the bond for the lower molar tubes and anterior brackets.

Fig. 9:
To open space for the blocked-in upper UL5, a Ni-Ti open coil spring was re-activated with flowable resin every month.

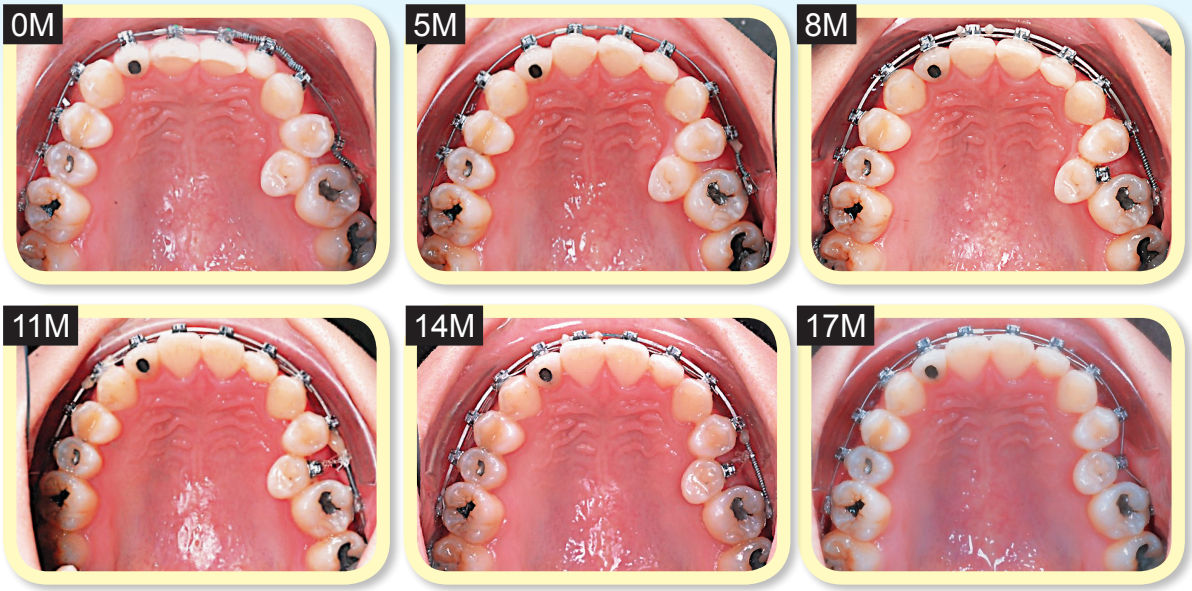


Fig. 10: Maxillary arch alignment is shown for the first seventeen months of treatment (0-17M). See text for details.

In the third month, the peg lateral incisors were restored to appropriate dimensions with composite resin, and the brackets were rebonded more gingivally to achieve an esthetic high-low-high relationship of the marginal gingiva (*Fig. 8*). A Ni-Ti open coil spring was reactivated with flowable resin every month (*Fig. 9*) to create space to align the UL5 (*Fig. 10*).

For the lower arch, the initial 0.014-in CuNiTi archwire was not engaged in the LR7 tube because it could be easily dislodged. In the fifth month, a 0.014x0.025-in NiTi archwire was engaged in the tube to upright the LR7. In the eighth month, a 0.016x0.025-in SS archwire was used to close the lower right molar space with a sliding mechanics. Lingual buttons were bonded on the LR4 and LR7 to facilitate space closure by balancing the force on the buccal and lingual surfaces with elastomeric chains.

In the fourteenth month, the LR space was closed and the LL7 was extracted, and the LL8 was free to erupt. At twenty-seven months (*27M*) the LR8 was surgically exposed and a RBS was placed to provide traction for uprighting (*Fig. 11*). The horizontally impacted LR8 was uprighted and efficiently aligned in about 9 months as shown in a progressive series of panoramic radiographs (*Fig. 12*).

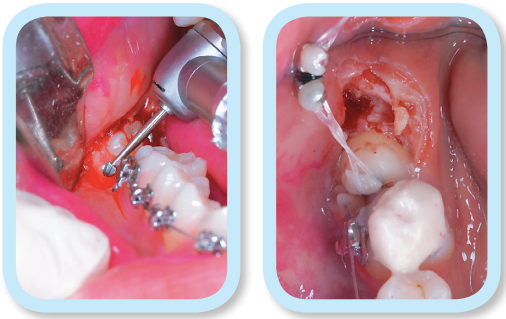
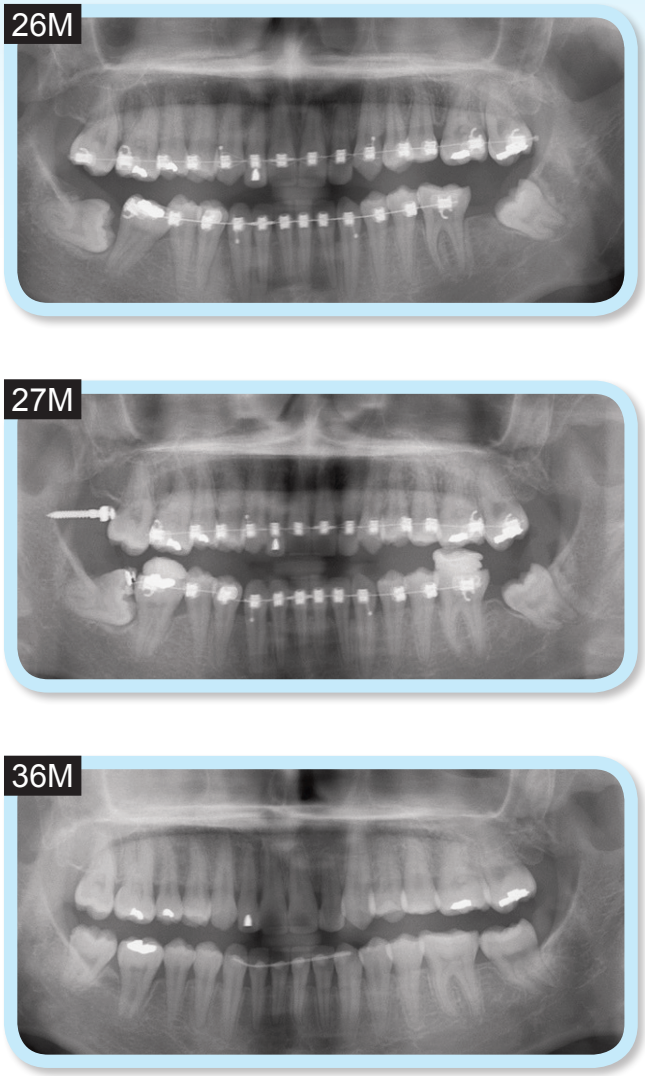


Fig. 11:
The horizontally impacted LR8 is surgically exposed (left). Uprighting traction is applied via a RBS anchored elastomeric chain (right). See text for details.



■ *Fig. 12:*
A progressive series of panoramic radiographs from 26-36 months (M) show the uprighting and alignment of the LR8. See text for details.

After thirty-six months of active treatment, all appliances were removed (*Fig. 13*). Retention was accomplished with a lower lingual fixed retainer that was augmented with maxillary and mandibular clear overlay retainers.

Treatment Results

The post-treatment photographs illustrate that the enhanced facial esthetics in both the profile and frontal views (*Fig. 13*). In addition, the smile arc is improved resulting in a more youthful appearance, and the previously blocked-in UL5 is well aligned. The patient was well satisfied with the outcome.

The divergent root form of the LL8 was superior to the conical shape of the LL7 (*Fig. 14*), which was an important factor in deciding to extract the LL7 and retain the LL8 (*Figs. 5 and 15*). Uprighting and substantial movement of mandibular molars is a risk factor for external root resorption.[4,7] However, no significant root resorption or other problems were noted for the current patient (*Fig. 15*). In addition, all molars remained vital, there was no excessive mobility, and the periodontal condition was satisfactory.

The post-treatment lateral cephalometric radiograph (*Fig. 16*) documents the improved facial profile, and TMJ radiography shows that normal joint morphology was retained (*Fig. 17*). Superimposed cephalometric tracings demonstrate increased axial inclination of the upper and lower incisors, maxillary molar retraction, and mesial moment of lower third molars to close space. There was no mandibular rotation so the LFH was unchanged (*Fig. 19, Table 1*).

The post-treatment casts (*Fig. 18*) were scored at 33 points with the ABO Cast-Radiograph Evaluation (*CRE*) method (*Worksheet 2*). The major CRE discrepancies were Class II occlusal relationships on the right side

Fig. 13: Post-treatment facial and intraoral photographs

Fig. 14:
Root form, divergence and trunk area are related to the periodontal prognosis as the level of bone support decreases. This is an important factor in deciding which molars to extract. See text for details.

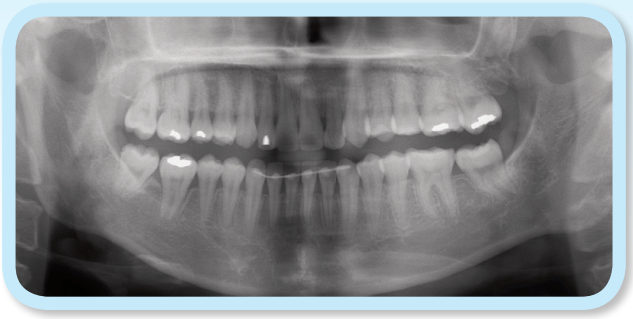


Fig. 15: Post-treatment panoramic radiograph

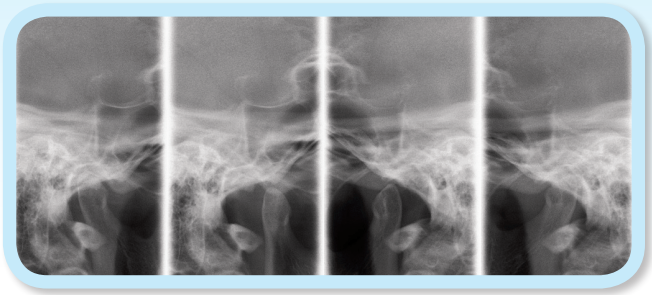


Fig. 17: Post-treatment TMJ radiography

Fig. 16: Post-treatment cephalometric radiograph

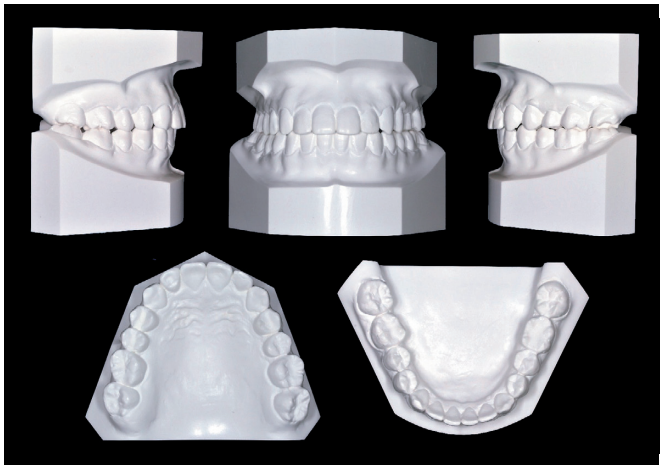


Fig. 18: Post-treatment study models (casts)

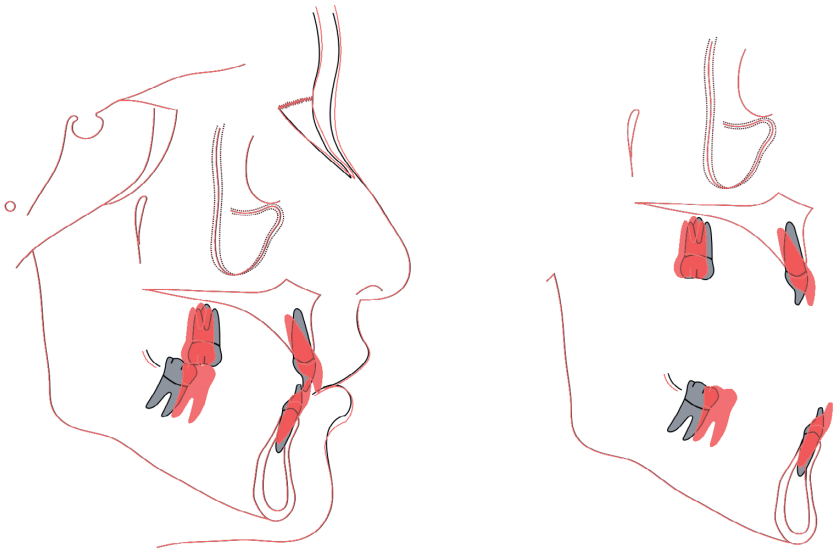


Fig. 19:
Cephalometric tracings from the start (black) and end (red) of active treatment are superimposed on the anterior cranial base (left), maxilla (upper right), and mandible (lower right). See text for details.

and buccolingual inclination bilaterally. Despite these discrepancies in dental alignment, the overall facial and dental esthetics were excellent (*Fig. 13*).

Discussion

Etiology

Two independent etiologies for this complex malocclusion were identified:

- MIH-related loss of the LR6 appeared to contribute to horizontal impaction of the LR8, as the LR7 drifted mesially (*Fig. 5*). This unusual scenario was compared to the typical pattern after loss of a lower first molar: mesial tipping of the erupting second molar, which is intensified by the erupting pressure of the third molar.[4] However, if the LR8 was mesioangular, as suggested by the third molar on the opposite side (*Fig. 5*), the LR8 probably became a full horizontal impaction as the LR7 moved mesially. The evidence for this scenario is the lack of LR7 tipping (*Fig. 5*), which apparently reflects eruptive pressure against the root of the LR7 as the LR8 tipped into a more horizontal position. In effect, the LR7 was translated into the edentulous space by a resultant force through the center of resistance of its roots (*Fig. 5*).

- Ectopic eruption of upper lateral incisors resulted in the premature loss of adjacent deciduous canine. The probable developmental scenario is: 1. all four maxillary incisors tipped lingually and to the left resulting in a midline discrepancy, 2. decreased axial inclination of upper and lower incisors (*88/81.5°*), 3. reduced lip prominence (*-4.5/-3.0mm to Ricketts E-line*), 4. deep overbite (*5mm*), 5. Class II buccal segments, and 6. upper left arch length deficiency ultimately resulted in ectopic eruption of the UL5 into the palate (*blocked-in*).

There are no known interceptive measures for an MIH-related loss of a lower first molar, but the occlusion could have been stabilized after the ectopic loss of the deciduous canine. Relatively simple interceptive treatment at age 7-8 years would have prevented a substantial portion of this asymmetric Class II malocclusion that proved difficult to completely correct (*DI 24*).

Reversing the etiology of malocclusion in the maxillary arch is illustrated in a series of occlusal photographs from the start of treatment (*0M*) to seventeen months (*17M*) into treatment (*Fig. 10*). The arch was lengthened by increasing the axial inclination of the incisors with a progression from round to rectangular archwires. At the same time, space was opened for the blocked-in UL5 with open coil spring, and it was moved buccally with a 0.014-in CuNiTi archwire inserted at seventeen months into treatment. A second progression from soft round to stiff rectangular archwires was used to finish the upper arch. In effect, a substantial series of applied mechanics was required to reverse the physiologic drift of the incisors lingually and to the left (*Figs. 1 and 3*).

RBS Anchorage

Substantial effort was required to close the previously missing molar space and to upright the horizontal impaction for alignment in the arch (*Figs. 20-30*). Since the uprighting of the LR8 did not begin until 27 months into treatment, there was concern about excessive overall treatment time. However, alignment of the upper arch (*Fig. 10*), followed by posterior space closure and molar alignment was the preferred treatment sequence. This approach corrected the patient's esthetic concerns early in treatment. In addition, alignment of the maxillary arch and space closure in the LR posterior segment prior to uprighting the LR8, resulted in longterm stability (*Fig. 31*) and an optimal periodontal result (*Fig. 32*). However, the preferred treatment sequence failed to completely correct the Class II sagittal relationship in the buccal segments (*Fig. 18*). It was not possible to achieve ideal buccal interdigitation within the designated treatment time without a potentially unesthetic retraction of the maxillary dentition. In addition, the decreased width of the maxilla relative to the mandible resulted in excessive buccal orientation of the maxillary molars. These complications resulted in a less than ideal final alignment (*CRE 33*), but that was deemed an acceptable compromise to achieve a good posterior occlusion (*Fig. 15*) and excellent dentofacial esthetics (*Fig. 13*). Additional advantages of the current approach were optimal periodontal health (*Fig. 31*) and longterm stability (*Figs. 32 & 33*).

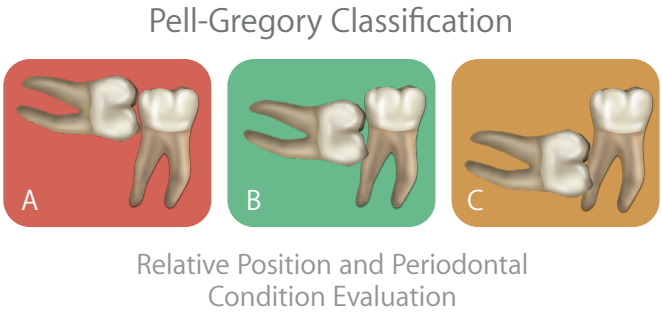


Fig. 20:
Relative position of a horizontal impaction is assessed according to Pell-Gregory Classification. Position A has the worst prognosis and B has the best prognosis. See text for details

Periodontal Health

Complex surgical and mechanical procedures such as uprighting of a deep, horizontal impaction may compromise the periodontium in areas where it is difficult to maintain oral hygiene. Careful periodontal assessment is indicated prior to, during and after treatment:

- Impaction prognosis evaluation: The root form, divergence, and trunk area are important considerations relative to periodontal prognosis.[8] Divergence of roots is preferable to fusion[9] because the former are easier to maintain long-term (*Fig. 14*).[10] Careful evaluation is indicated for all impacted molars being considered for uncovering and uprighting.[11] The decision to pursue the uprighting of an impaction is largely dependent on the clinician's experience.[8-10]

- Position of the impacted molar: There are 3 types of horizontally impacted molars according to the Pell-Gregory Classification (*Fig. 20*).[11] Position B is

the best candidate for uprighting, and Position A is the worst, even though it is more superficial. Uprighting a Position A impaction can result in occlusal trauma and opening of space distal to the erupted posterior segment. Subsequent tooth movement, under potentially traumatic conditions, may compromise periodontal health. Position C is the most favorable for uprighting mechanics, but RBS anchorage is required because conventional orthodontics for deep impactions is often difficult and risky for the periodontium.

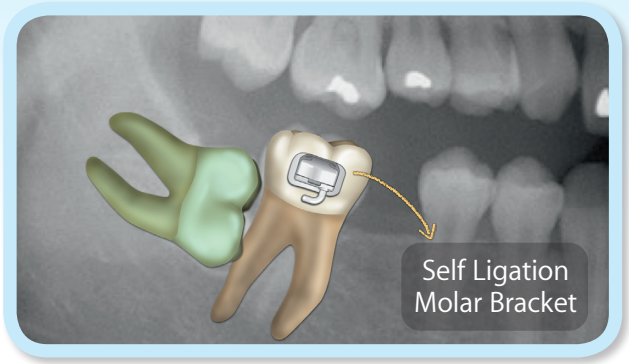


Fig. 21:
A self ligating molar bracket is the best choice for the erupted molar (LR7), so that an archwire can be inserted from the buccal.

Ramus Bone Screws

The RBS technique is an efficient posterior anchorage mechanism for producing an uprighting moment to rotate deep, horizontal impactions in the sagittal plane.[6,7,12,13] The procedures for this technique-sensitive clinical method are challenging, so a guideline for clinical efficiency is provided:

1. **Bond a PSL bracket on the LR7 mesial to the impaction**: archwires can be inserted into PSL brackets from the anterior or buccal direction, which is helpful for the surgical and orthodontic procedures shown in Figs. 21-30. It is difficult to feed a flexible wire through two molar tubes, especially when there is a substantial discrepancy (*Fig. 28*). Also, an open coil spring may be useful for uprighting the impaction. After the spring is activated, the archwire can be seated in the bracket of the mesial molar from the buccal direction (*Fig. 28*). PSL brackets are just as easy to bond on a first molar as a tube, but they are much more versatile (*Fig. 21*).

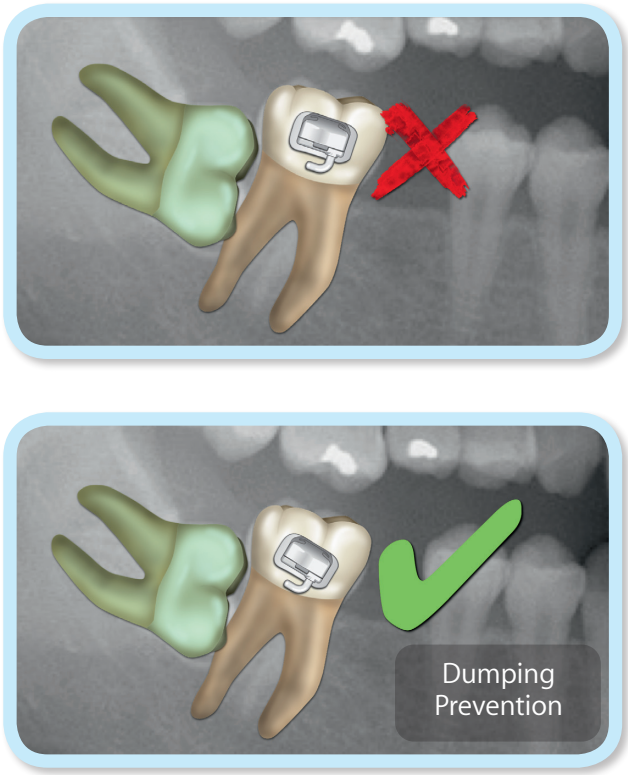


Fig. 22:
Rather than the ideal bracket position (upper), the molar bracket should be positioned more gingivally on the mesial (slight clockwise rotation) to provide a root forward moment as the missing first molar space is closed (lower). This procedure is deemed Dumping Prevention.

2. **Rotate the LR7 bracket down on the mesial**: Moving the molar mesially to close space will tip it to the mesial unless the bracket delivers a counter moment to maintain the axial inclination (*Fig. 22*). The bracket on a tooth tipped mesially during space closure results in more friction at the archwire interface and may notch it, thereby decreasing the rate of tooth movement.[12]

3. **Lingual buttons and an elastomeric chain**: Balance the buccal and lingual force for space closure to avoid mesial-in rotation as the space is closed. Similar to mesial tipping, mesial-in rotation increases friction on the archwire, decreases the rate of tooth movement, and results in an undesirable position of the molar after space closure.[12]

4. **Protract the second molar to create space to upright the third molar**: Creating space mesial to the impacted third molar has a number of advantages. First, it avoids disrupting the epithelial attachment on the second molar when the third molar is uncovered. Second, the space insures that the undercut at the cementoenamel junction (*CEJ*) is avoided as the third molar is uprighted. Three, as space is opened by mesial molar movement, the third molar may have a tendency for some spontaneous vertical movement and uprighting[14] which simplifies the recovery procedure (*Fig. 23*).

5. **Surgical exposure and removal of all obstacles**: Overlying bone must be removed in 3D to the level of the CEJ (*Fig. 24*).[7] When enamel contacts bone during the uprighting process, little bone resorption occurs because osteoclasts to achieve tooth movement are sourced from the periodontal ligament.

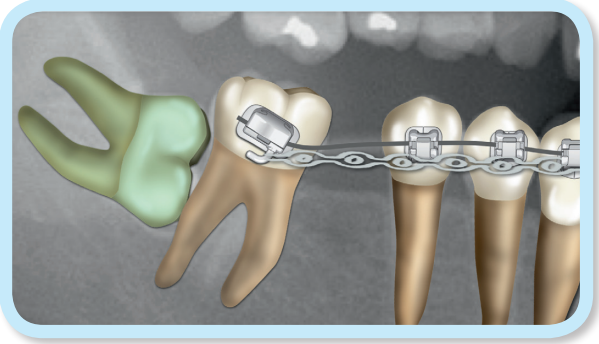


Fig. 23:
Move the LR7 mesially into the missing LR6 space to initiate self-uprighting and vertical movement in preparation for recovering the LR8.

Fig. 24:
Surgically uncover the LR8 and remove all bone down the CEJ (upper drawing). In the frontal plane remove any obstacle to eruption especially bone (lower drawing).

6. **Luxate the impacted molar with an elevator**: this procedure ensures the impaction is not ankylosed (*Fig. 25*) and also stimulates turnover in adjacent bone via the regional accelerator phenomenon.[15]

7. **Second molar should be a "free body" when the third molar is uprighted**: To prevent root resorption, the second molar should be free to move out of the path of eruption for the third molar (*Fig. 26*). If the second molar is engaged on an archwire, it should be of small diameter and flexible.[12]

8. **A RBS should be a 2x14mm SS self-drilling screw**: Pilot hole drilling is not a viable procedure in the anterior ramus because of the thickness of the overlying soft tissue. A self-drilling screw with a length of 14mm is necessary to provide adequate head to mucosa clearance, within the oral cavity, to avoid soft tissue irritation.[6,7,12,13]

9. **Eyelet bonding**: once the crown of the third molar is prepared, the area should be carefully isolated to permit a chalky white etching of the enamel surface, without saliva or blood contamination.

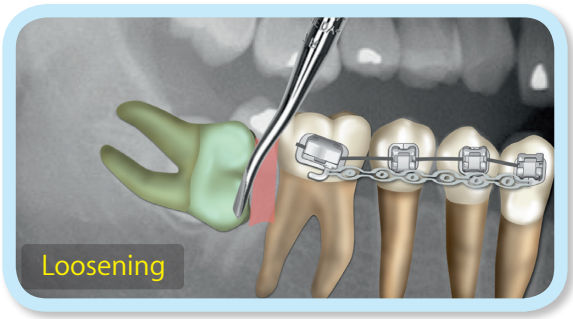


Fig. 25:
Loosen the impacted molar with an elevator to make sure it is not ankylosed.

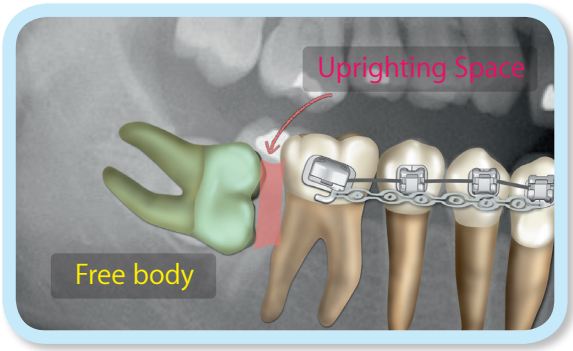
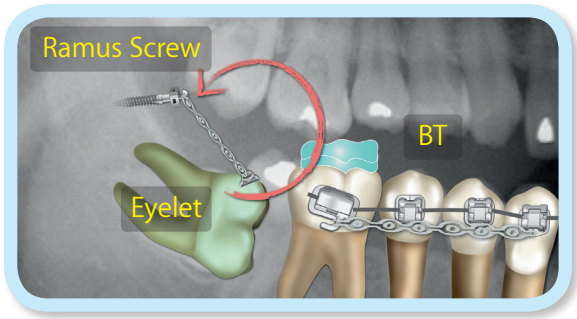


Fig. 26:
Make sure the anterior molar (LR7) is a free body, meaning it is allowed to move out of the path of eruption of the LR8 during the uprighting process. The space created by moving the LR7 mesially is the uprighting space (pink). See text for details.



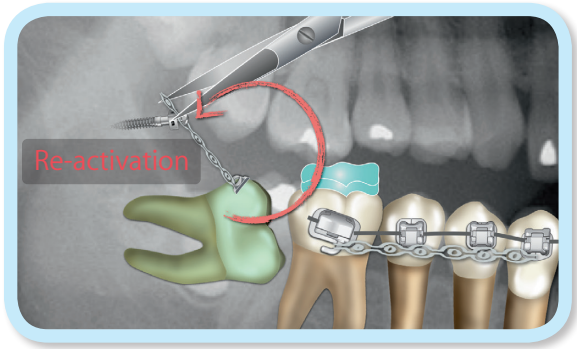


Fig. 27:
Upper Drawing: The ramus screw anchors an elastomeric chain attached to the eyelet on the LR8. A moment (pink curved arrow) uprights the impaction with a counterclockwise rotation. The bite turbo (BT) bonded to the occlusal surface of the LR7 (blue) opens the bite to prevent occlusal trauma.

Lower Drawing: The monthly activation procedure is to stretch the elastomeric chain one loop, and then reengage it on the RBS. The increase in force reactivates the moment (pink curved arrow). Then the extra link superior to the RBS is excised with the scissors as shown.

10. **Bite turbos**: Glass ionomer cement about 4-5mm thick should be bonded on lower molars bilaterally to provide space for uprighting the impaction without occlusal or bone screw interference.

11. **Activation**: A chain of elastics is attached from the RBS to the eyelet on the impaction, and it is reactivated by removing a loop from the chain once per month (*Fig. 27*).

12. **Adequate uprighting to permit bonding a buccal tube on the third molar**: Carefully monitor progress and stop the uprighting activation when sufficient buccal enamel is exposed to bond a bracket. Excessive extrusion due to uprighting results in occlusal trauma and requires complex mechanics for intrusion.

13. **Bond a buccal tube and apply archwire mechanics**: Mount the tube more gingivally on its mesial surface to produce an uprighting moment when an 0.018-in or 0.014x0.025-in CuNiTi archwire is inserted (*Fig. 28*).

14. **Occlusal adjustment**: Patients should be warned that occlusal adjustment may be necessary (*Fig. 29*) because uncontrolled occlusal trauma may result in failure of the impaction recovery procedure.

15. **Progressively reposition the third molar tube and remove the bite turbos**: Repositioning the tube is usually more predictable than archwire adjustment for detailing the position of the recovered impaction. Progressively remove the bite turbos as the third molar is aligned (*Fig. 30*).

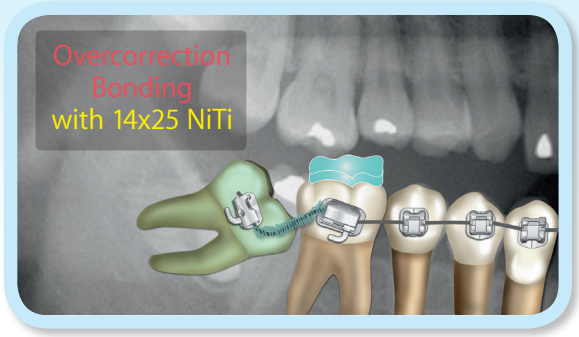


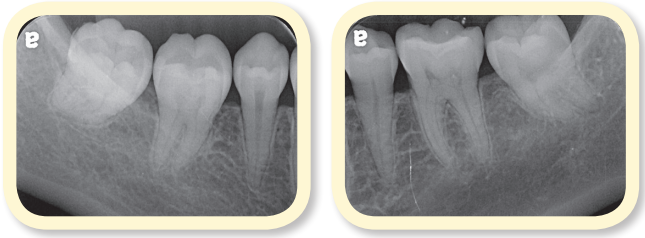
Fig. 28:
The bracket on the impaction is bonded in a position that is slightly clockwise the ideal buccal position. This procedure is deemed Overcorrection Bonding. Uprighting of the LR8 is continued with a 0.014-in NiTi archwire with an open coil spring between the molars.

Fig. 29:
Occlusal adjustment may be required to prevent functional trauma.

Fig. 30:
Detail the positioning of the recovered LR8 by rebonding the bracket as needed.

■ *Fig. 31:*
Two years post-treatment follow up records: facial and intraoral photographs

■ *Fig. 32:*
Two years follow up shows that periodontal health is normal. There was minimal pocket depth with no bleeding on the mesial surface of both lower terminal molars.



■ *Fig. 33:*
The three-year, follow-up peri-apical film shows that the bone height around 3rd molar was within normal range.

Conclusions

The etiology of a malocclusion is the basis for planning efficient treatment. Simplicity is the ultimate sophistication. Even through ramus screw mechanics may seem easy and intuitive, the devil is in the details. RBSs are an elegant solution for recovering deep, horizontal impactions and aligning them in normal occlusion, but it is a complex procedure. This case report presents the successful treatment for a severe acquired malocclusion with RBS anchorage. Important treatment details are outlined and illustrated. Two year and three year follow-up showed excellent stability with good periodontal health. Intermaxillary alignment may be improved by uprighting horizontal impactions earlier in treatment.

Acknowledgment

Thanks to Mr. Paul Head for proofreading this article.

References

1. Hysi D, Kusco OO, Droboniku E, Toti C, Xhennica L, Calgary E. Prevalence and aetiology of molar-incisor hypomineralization among children aged 8-10 year in Tirana, Albania. Eur J Paediatr Dent 2016;17(1):75-9.
2. Da Costa-Silva CM, Jeremias F, De Souza JF, Cordeiro Rde C, Santos-Pinto L, Zuanon AC. Molar incisor hypomineralization: prevalence, severity and clinical consequences in Brazilian children. Int J Paediatr Dent 2010;20(6):426-34.
3. Chang MJ, Chang CH, Roberts WE. Acquired malocclusion due to early loss of permanent first molars: OBS-anchored orthodontics and implant-supported prostheses. Int J Orthod Implantol 2016;42:20-41.
4. Roberts WE, Nelson CL, Goodacre CJ. Rigid implant anchorage to close a mandibular first molar extraction site. J Clin Orthod 1994;28(12):693-704.
5. Lin JJ. The wisdom of managing wisdom teeth-Part III. Methods of molar uprighting. Int J Orthod Implantol 2011;24:4–11.
6. Lin SY, Chang CH, Roberts WE. Simple mechanics to upright horizontally impacted molars with ramus screws. Int J Orthod Implantol 2015;40:84–92.
7. Chang CH, Lin SY, Roberts WE. Forty consecutive ramus bone screws used to correct horizontally impacted mandibular molars. Int J Orthod Implantol 2016;41:60-72.
8. Bower RC. Furcation morphology relative to periodontal treatment. Furcation root surface anatomy. J Periodontol 1979;50(7):366–74.
9. Gher ME, Vernino AR. Root morphology-clinical significance in pathogenesis and treatment of periodontal disease. J Am Dent Assoc 1980;101(4):627–33.
10. Schroeder HE. The effects of furcation morphology on periodontal disease. Dtsch Zahnarztl Z 1991;46(5):324–7.
11. Pell GJ, Gregory BT. Impacted mandibular third molars: classification and modified techniques for removal. Dent Dig 1933;39:330–8.
12. Lin SL, Chang CH, Roberts WE. Uprighting and protracting a horizontally impacted lower third molar in an adult. Int J Orthod Implantol 2014;34:58–77.
13. Lee MC, Chang CH, Roberts WE. Compensated, asymmetric Class II malocclusion with horizontal impaction of mandibular second molars. Int J Orthod Implantol 2014;33:50–62.
14. Baik UB, Kook YA, Bayome M, Park JU, Park JH. Vertical eruption patterns of impacted mandibular molars after the mesialization of second molars with miniscrews. Angle Orthod 2016;86(4):565-70.
15. Frost HM. A 2003 update on bone physiology and Wolff's law for clinicians. Angle Orthod 2004;74(1):3-15.

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.
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 = 0

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	_____ pts.
Full Class II or III	=	4 pts. per side	_____ pts.
Beyond Class II or III	=	1 pt. per mm. additional	_____ pts.

Total = 4

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 2

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 2

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

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

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

SN-MP

≥ 38° = 2 pts.

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

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 0

OTHER (See Instructions)

Supernumerary teeth	_____	x 1 pt. =	_____
Ankylosis of perm. teeth	_____	x 2 pts. =	_____
Anomalous morphology	_____	x 2 pts. =	_____
Impaction (except 3rd molars)	_____	x 2 pts. =	2
Midline discrepancy (≥3mm)		@ 2 pts. =	2
Missing teeth (except 3rd molars)	_____	x 1 pts. =	2
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	0	x 2 pts. =	0

Identify:

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) =_ 1

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 = 1

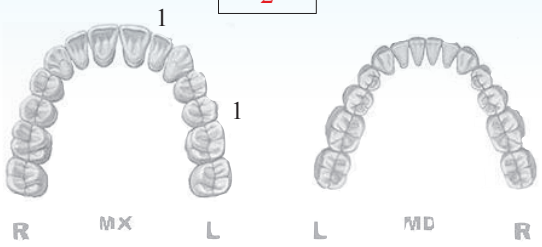
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 33

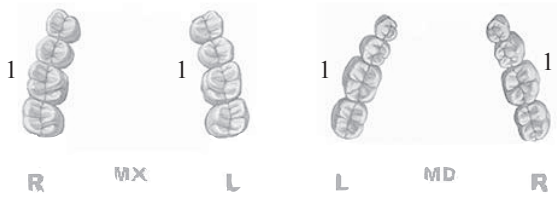
Alignment/Rotations

2



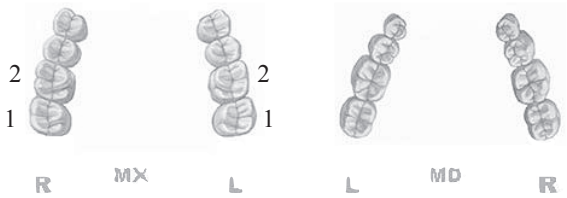
Marginal Ridges

4



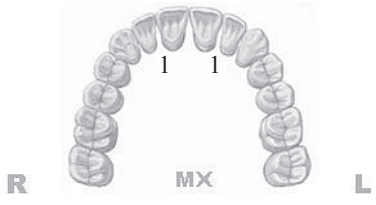
Buccolingual Inclination

6



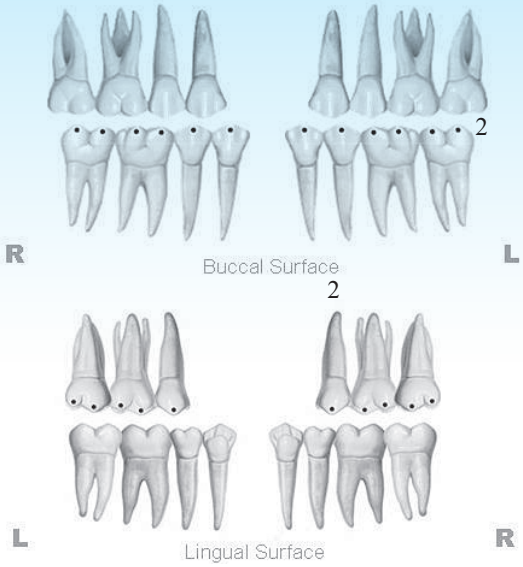
Overjet

2



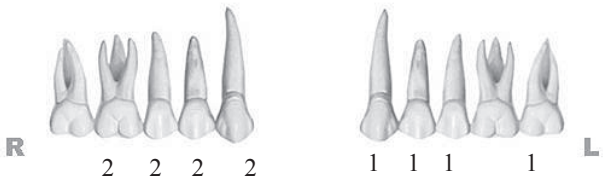
Occlusal Contacts

4



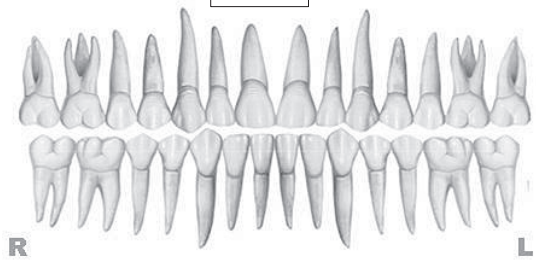
Occlusal Relationships

12



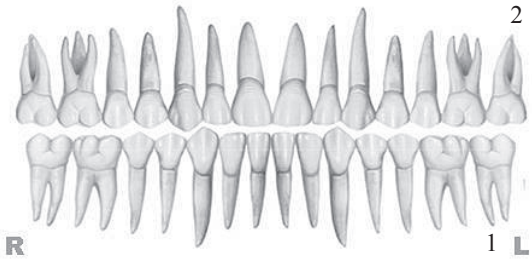
Interproximal Contacts

0



Root Angulation

3



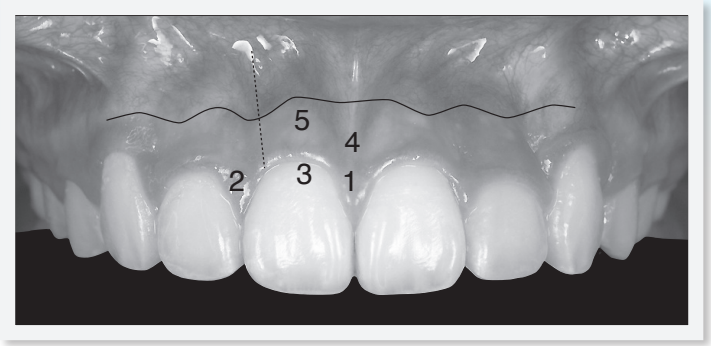
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 0

1. Pink Esthetic Score

Total = 0

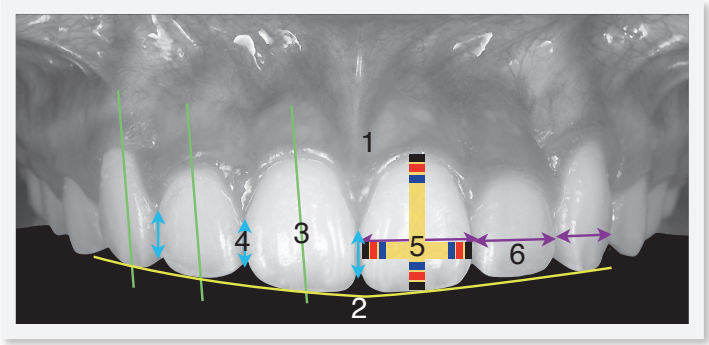


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

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 = 0



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