

Class II Division 1 Malocclusion with 5 mm of Crowding Treated Non-Extraction with IZC Miniscrews Anchorage

Abstract

A Class II Division 1 malocclusion in a 26 yr old male was associated with a convex profile (ANB 5.5), lip incompetence, 7 mm of overjet, and 5-7 mm of crowding in each arch. This complex malocclusion in an adult male was treated non-extraction, by retracting both arches, and intruding the incisors with anterior bite turbos, placed on the lingual surfaces of upper central incisors. Following 25 months of active treatment, this difficult malocclusion (DI 21) was treated to an excellent dental (CRE 17) and facial result. (Int J Orthod Implantol 2016;41:4-17)

Key words:

Class II Division 1, IZC bone screws, miniscrews, bite turbo, adult male

History and Etiology

A 26 year-old male presented with compromised facial and dental esthetics, associated with a complex malocclusion: 19° facial convexity ($G-Sn-Pg^\wedge$), Class II buccal segments, 7 mm overjet, 4 mm deep overbite, lip incompetence with mentalis strain (Figs. 1-3). Medical and dental histories were non-contributory. A functional examination of the temporomandibular joint was within normal limits (WNL). Careful assessment of the facial and dental discrepancies suggested that maxillary bone screw anchorage was a viable approach for differentially retracting both arches to resolve the complex malocclusion. Temporary anchorage devices (TADs) were placed in the infrazygomatic crest (IZC) region, bilaterally. Following 25 months of non-extraction treatment with IZC TADs, the malocclusion was corrected to a near ideal result with a passive self-ligating appliance (Figs. 4-6). The treatment is documented with lateral cephalometric and panoramic radiographs before (Fig. 7) and after (Fig. 8) treatment, as well as superimposition of cephalometric tracings (Fig. 9).

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Fig. 1: Pre-treatment facial photographs show a convex profile with chin retrusion, lip incompetence and mentalis strain. Note that the chin point is deviated slightly to the right.



Fig. 4: Post-treatment facial photographs.



Fig. 2: Pre-treatment intraoral photographs reveal bilateral Class II buccal segments. The lower dental midline is deviated to right about 1.5 mm. The overjet was 7 mm and the overbite was 4 mm (40%).



Fig. 5: Post-treatment intraoral photographs document a well aligned dentition, but there are multiple interproximal black triangles.



Fig. 3: Pre-treatment study models (casts) document a complex malocclusion with a DI of 21.

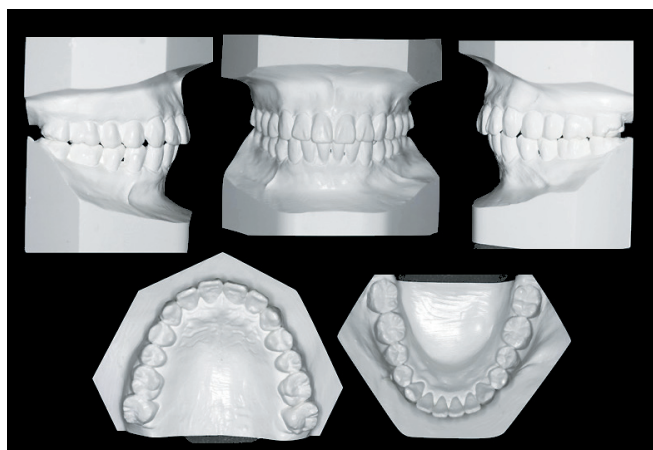
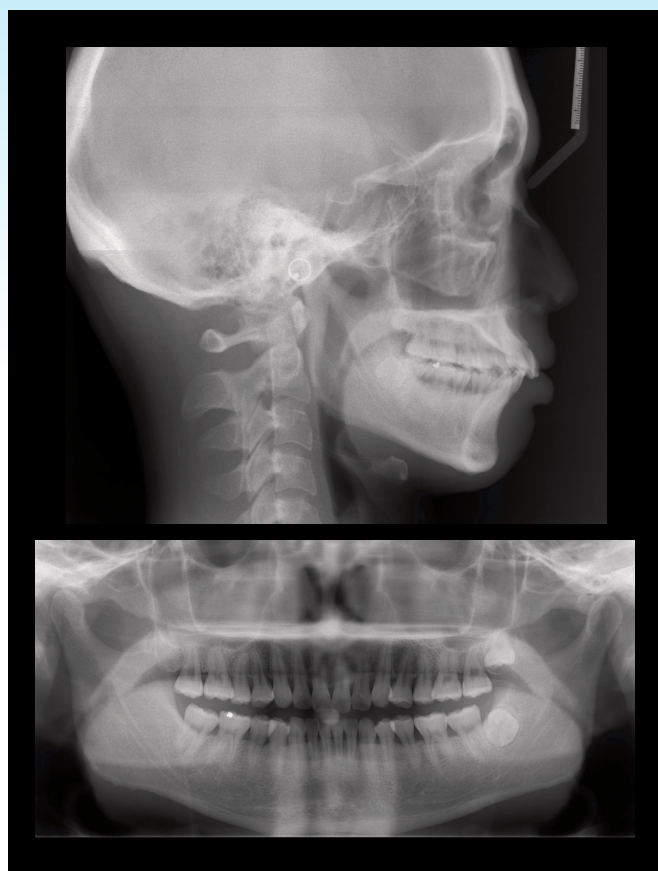
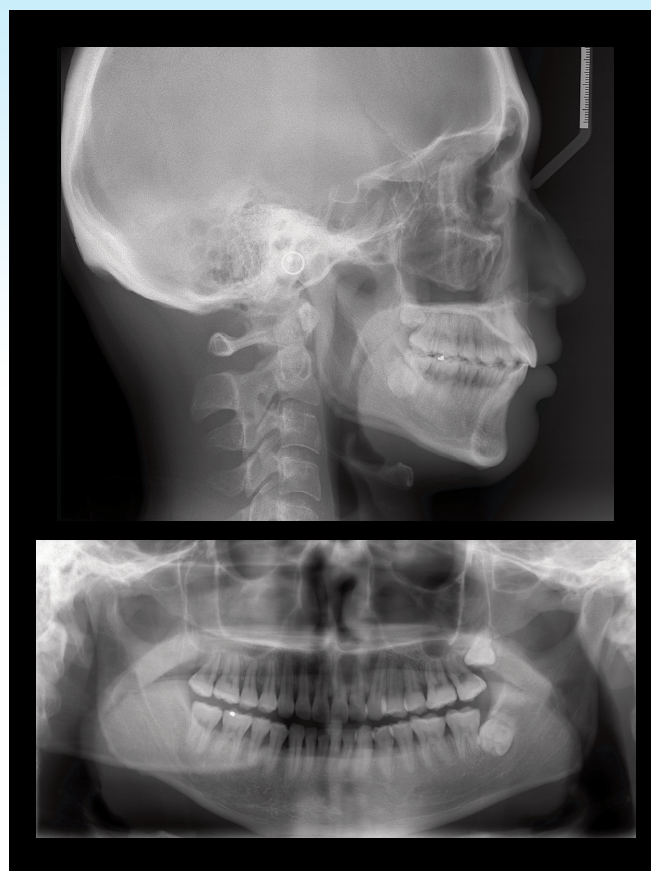


Fig. 6: Post-treatment study models (casts) document a good alignment that earned a CRE score of 17 points.



■ **Fig. 7:**
Pre-treatment cephalometric and panoramic radiographs



■ **Fig. 8:**
Post-treatment cephalometric and panoramic radiographs



■ **Fig. 9:**
Cephalometric superimpositions reveal the Class II malocclusion was corrected by upper arch retraction and bite opening was achieved by upper and lower incisor intrusion. The initial positions for the teeth and lips are shown in blue and the results are shown in red.

Diagnosis and Etiology

Pre-treatment facial photographs show a convex profile, protrusive lips, chin retrusion, mentalis strain, and a chin point that was deviated slightly to the right (Fig. 1). Intraoral photographs and study casts (Figs. 2 and 3) document Class II canine and molar relationships bilaterally, 7 mm of overjet, a 4 mm deep overbite (40%), and significant crowding in both arches (-5mm upper, -7mm lower). The cephalometric analysis (Table 1) reveals a skeletal Class II pattern (ANB 5.5°), protrusive lips, increased axial inclination of all incisors (U1-SN 118.1°, L1-MP 99.2°), and a mandibular plane angle that was within normal limits (WNL). Skeletal, dental and facial analysis is outlined below.

Skeletal:

- Skeletal Class II Pattern: SNA 84.2°, SNB 78.8°, and ANB 5.5°
- Mandibular plane angle is WNL: SN-MP 32.2°, FMA 22.8°
- Facial asymmetry: chin point is deviated slightly to the right

Dental:

- Bilateral Class II buccal segments: molars ~2 mm and canines ~5 mm
- Right side canine Class II, left side Class I
- Overjet is 7 mm
- Overbite is 4 mm (40%)
- Crowding: 5 mm in the upper and 7 mm in the lower arches
- Impacted third molars: upper and lower left segments

- Midlines: upper dental midline is coincident with the facial midline, and the lower midline deviates about 1.5 mm to the right.
- Arch forms: asymmetric buccal and lingual displacements of second premolars in both arches

Facial:

- Profile: increased convexity (19° G-Sn-Pg')
- Nasolabial Angle: WNL
- Mandible is retrognathic to the maxilla
- Incompetent Lips: mentalis strain and slight lower lip eversion when lips are closed

The ABO Discrepancy Index (DI) was 21 as shown in the subsequent worksheet.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	84.2°	84.1°	-0.1°
SNB°	78.8°	78.7°	-0.1°
ANB°	5.5°	5.4°	-0.1°
SN-MP°	32.2°	31.7°	-0.5°
FMA°	22.8°	22.1°	-0.7°
DENTAL ANALYSIS			
U1 TO NA mm	7.3 mm	2.3mm	-5.0 mm
U1 TO SN°	118.1°	105.0°	-13.1°
L1 TO NB mm	8.5 mm	7.0 mm	-1.5 mm
L1 TO MP°	99.2°	96.5°	-2.7°
FACIAL ANALYSIS			
E-LINE UL	-0.1 mm	-0.7 mm	-0.6mm
E-LINE LL	3.0 mm	1.3 mm	-1.7 mm

■ Table 1: Cephalometric summary

Treatment Objectives

A thorough examination and discussion with the patient produced the following treatment objectives:

1. Level and align the dentition in both arches.
2. Reduce the large overjet and correct the excessive axial inclination of the incisors.
3. Retract the lips to relieve mentalis strain and lip eversion.

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 incisors*
- Vertical: *Intrude incisors*
- Transverse: *Expand*

Mandibular Dentition:

- A - P: *Retract incisors*
- Vertical: *Intrude lower anteriors slightly*
- Transverse: *Expand*

Facial Esthetics:

- Retract the lips
- Relieve mentalis strain

Treatment Plan

Non-extraction treatment with a full fixed orthodontic appliance is planned to align the dentition, level the arches, and reduce the excessive overjet. The IZC bone screws selected are 2x8 mm stainless steel (SS). Bilateral IZC TADs provide anchorage for retraction of the upper dentition to correct the Class II discrepancy. Class III elastics from the IZC TADs are used to retract the lower dentition to correct the axial inclination of the incisors.

Appliances and Treatment Progress

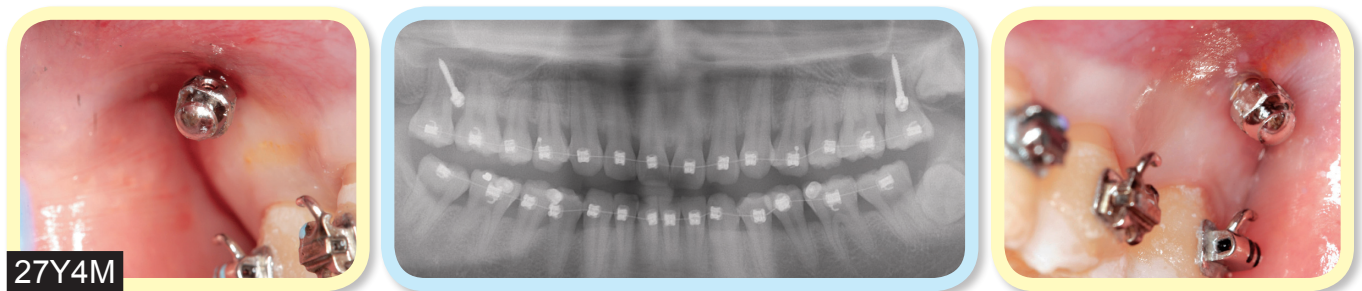
A full fixed .022" slot Damon Q® PSL appliance (Ormco, Glendora, CA) was bonded on teeth in both arches. All brackets were standard torque as specified by the manufacturer except for the lower anteriors, where low torque brackets were used to decrease labial proclination. The initial archwires were .014" CuNiTi in both arches, and 2x8 mm SS IZC miniscrews were installed buccal to the upper second molars, bilaterally. Upper arch retraction was initiated at the start of treatment by applying a chain of elastics from each maxillary TAD to the corresponding upper first premolar (Figs. 10 and 11).

Beginning two months into treatment, cross elastics were applied from the buttons bonded on the lingual of the lower 2nd premolars and 1st molars, to the buccal surface of the upper 1st and 2nd premolars to correct the posterior buccal crossbite. These cross elastics were used for about 9 months (Fig. 12). At four months into treatment, Class III elastics, from the IZC miniscrews to the lower canines, were used to retract the lower dentition to correct the



■ Fig. 10:

Start of active treatment (27yr 4mo): full fixed appliance, two IZC screws and bilateral elastic chains to the maxillary first premolars



■ Fig. 11:

At 27yr 4mo magnified views of the IZC screws and a panoramic radiograph show the position and soft tissue tolerance of the TADs.



■ Fig. 12:

At 27yr 6mo the posterior crossbite tendency was corrected with elastics attached to buttons bonded on the lingual surfaces of the mandibular first molars and second premolars.

excessive axial inclination of the lower incisors, as the arch was leveled and aligned (Fig. 13). After 6 months of differential retraction of both arches with IZC miniscrews, the buccal segments were near Class I (Fig. 14).

In the 12th month of treatment, bite opening stops (*turbos*) composed of glass ionomer cement were bonded on the lingual surfaces of the upper central incisors. The bite turbos opened the bite, thereby providing an intrusive force on the upper and lower incisors, and also creating a posterior open bite to facilitate crossbite correction. As the arches were leveled and aligned, spaces were created distal to the upper lateral incisors by buccal segment retraction. Posts were crimped on the archwire distal to the lateral incisors, and the upper anterior segment was retracted with chains of elastics anchored by the IZC screws (Fig. 15).

In the 14th month of treatment, the bite turbos were removed and the upper archwire was cut mesial to the upper 2nd molars. Vertical elastics were used to extrude the upper second molars to improve occlusal contacts (Fig. 16). After 23 months of treatment, detailing and finishing is almost complete (Fig. 17).



■ Fig. 13: At 27yr 7mo Class III elastics are applied from the IZC screws to the lower canines.



■ Fig. 14: After 6 months of active treatment (27yr 10mo), posterior segments are near a Class I occlusion.



■ Fig. 15:

At 28yr 3mo glass ionomer bite turbos are bonded on the lingual surface of upper central incisors to provide an intrusive force on the upper and lower incisors, in addition to opening the posterior bite to facilitate crossbite correction.



■ Fig. 16:

At 28yr 6mo the glass ionomer bite turbos were removed and the upper archwire was cut distal to the upper 1st molars, and vertical elastics were used to extrude the 2nd molars into occlusion.



■ Fig. 17: At 29yr 3mo bracket repositioning and archwire detailing were completed, immediately prior to debonding.

Result Achieved

The American Board of Orthodontics (ABO) Cast-Radiograph Evaluation (CRE) was 17 as scored in the subsequent worksheet. This is an excellent result for a difficult malocclusion (DI 21). Post-treatment documentation is provided with clinical photographs (Figs. 4-6), radiographs (Fig. 8), cephalometric tracings

(Fig. 9), and cephalometric measurements (Table 1). Despite the large overjet and deep overbite present initially, a near ideal incisal relationship was achieved (Figs. 5 and 6), and the buccal occlusal relationships were Class I bilaterally.

Maxilla (all three planes):

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

Mandible (all three planes):

- A - P: *Maintained*
- Vertical: *Closed slightly as the mandible rotated counter-clockwise*
- Transverse: *Maintained*

Maxillary Dentition:

- A - P: *Retracted*
- Vertical: *Intruded incisors*
- Transverse: *Expanded to resolve posterior crossbites*

Mandibular Dentition:

- A - P: *Slightly retracted lower arch*
- Vertical: *Intruded lower incisors*
- Transverse: *Expanded*

Facial Esthetics:

- Both upper and lower lips are retracted to improve facial balance
- Mentalis strain is relieved
- Marked improvement in overall facial esthetics

Retention

A Begg (*wrap-around type*) retainer was delivered for the well aligned maxillary arch, but the lower right central incisor was slightly rotated, so a spring retainer was required to complete lower anterior alignment. The patient was instructed to wear the retainers full time for the first 6 months and nights only thereafter. In addition, instructions were provided for proper home hygiene as well as for maintenance of the retainers.

Final Evaluation of Treatment

Following the final alignment of the lower anterior region with the spring retainer, an excellent alignment was achieved, as evidenced by an ABO CRE score of 17 points. Residual deficiencies were alignment/rotations (3), marginal ridges (4), buccolingual inclination (2), occlusal contacts (2), occlusal relationships (4), and axial inclinations (2). Overall, the patient needs were well addressed, and he was quite satisfied with the treatment outcome.

Discussion

Class II malocclusions with moderate crowding can be well aligned with the passive self-ligating bracket systems, but the outcome is often marred by incisal flaring, lip protrusion and incompetent lips. If these problems are present prior to treatment, extraction of premolars is usually required, but the latter approach entails the risk of excessive incisal retraction and compromised facial esthetics. Posterior maxillary anchorage with IZC bone screws offers an attractive option for Class II patients, with

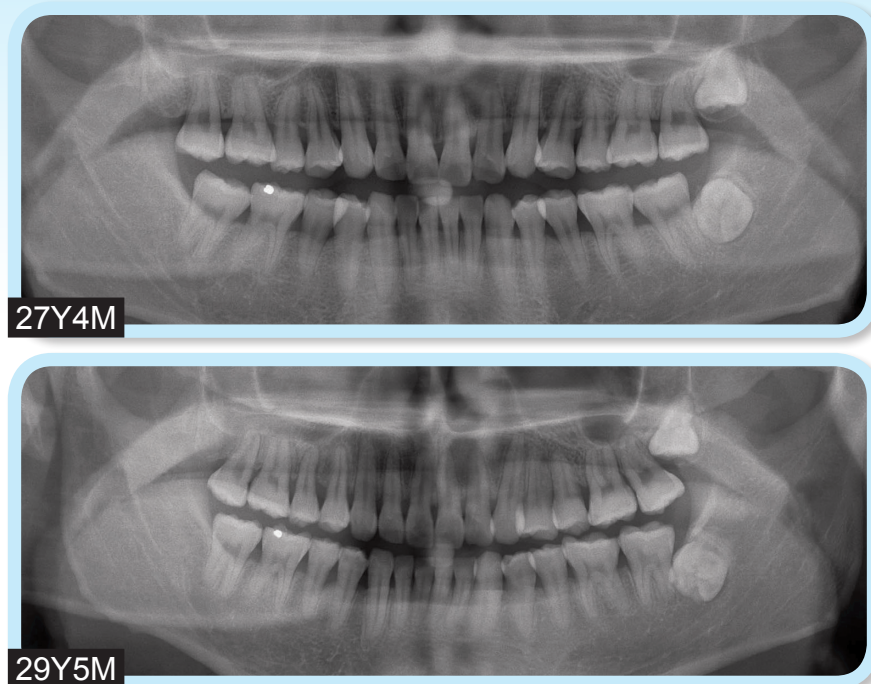
an excessive ANB angle and flared incisors in both arches. These TADs are well positioned to provide osseous anchorage for differential retraction of the dentition in both arches to simultaneously correct incisal inclinations and buccal interdigitation. In addition, IZC bone screws are effective intra-arch anchorage for lower arch retraction, using Class III elastics with a passive self-ligating appliance.¹⁻³ The differential retraction of both arches with IZC bone screws is efficient mechanics for a variety of skeletal and dental malocclusions, particularly in conjunction with a low friction, passive self ligating appliance. Both arches can be retracted simultaneously as they are leveled and aligned.³

Interproximal enamel reduction (IPR) is effective therapy for a variety of problems, such as: 1. crowding, 2. a Bolton ratio discrepancy, 3. irregular tooth shape, 4. eliminating black triangles in the anterior segments, and 5. leveling of the Curve of Spee.⁴⁻⁸ For the present patient, the anterior Bolton ratio was 75.7%, which indicated 1 mm excess in the width of the upper anteriors.^{10,11} This problem precluded IPR to correct the black triangles in the lower anterior region, because reduction in the width of the mandibular incisors would probably result in excessive overjet and a deepbite. No IPR was performed because the upper arch was successfully retracted with bone screw anchorage, but if the IZC screws had failed and the patient declined extractions, IPR was a viable alternative. If IPR was performed in anterior segments of both arches, the black triangles would have been reduced in the lower arch, and the Bolton excess would be corrected in the upper arch. In addition to correcting tooth-size discrepancies, interproximal

enamel reduction is emerging as a viable alternative for correcting crowding. When mesial migration of the dentition is controlled, stripping 0.25 mm from all interproximal surfaces of 16 teeth in a full arch, results in 7.5 mm of arch length, which is approximately the width of a premolar. Thus, IPR and molar retraction with extra-alveolar TADs are a viable alternative to premolar extractions, that is consistent with optimal outcomes.

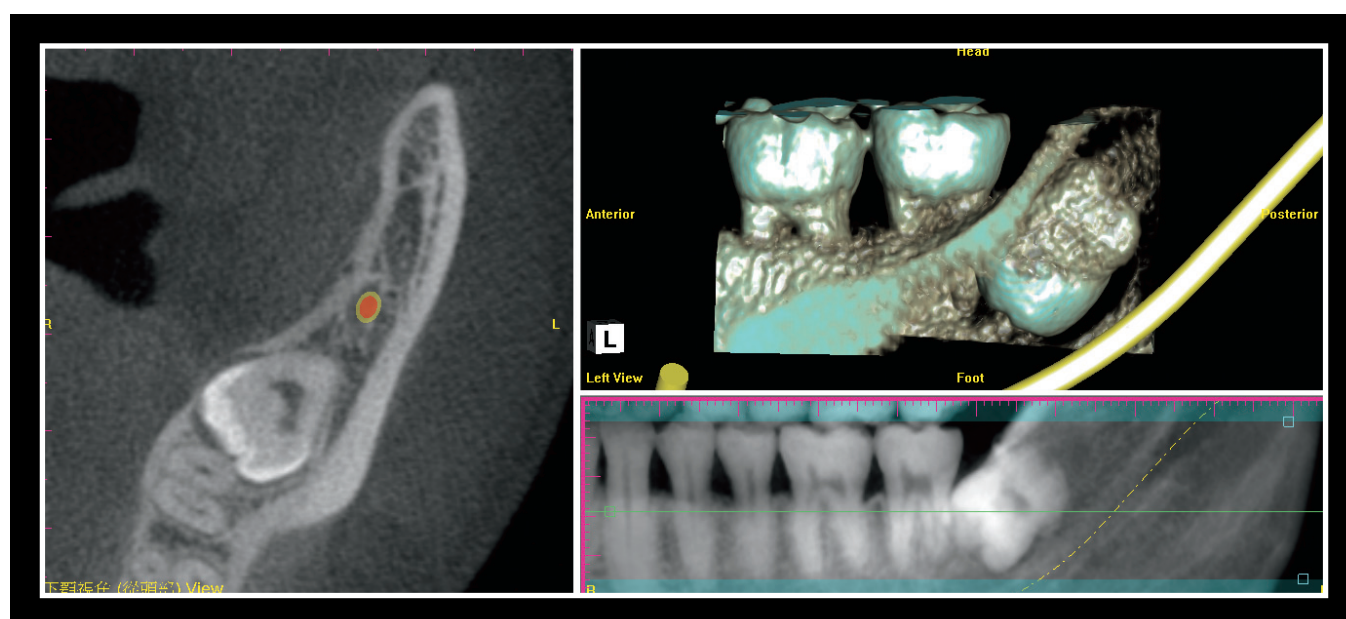
Impacted third molars are a concern when arches are retracted to correct a malocclusion (*Fig. 7*). It may be preferable to remove impactions prior to the initiation of arch retraction, but some patients and clinicians are resistant to surgical removal of impactions because of the post-operative morbidity, as well as the potential for damaging the adjacent second molars and nerves. Proceeding with arch retraction without removing the impactions risks root resorption and/or tipping of the second molars, as noted in the final panoramic film. Despite the impacted third molar, the axial inclination of the lower left second molar was WNL, but both maxillary second molars were distally inclined, and were scored at 1 point each on the CRE (*Fig. 18*). This was a surprising result because of the severe mesioapical orientation of the lower left third molar in 2D (*Fig. 8*) until a CBCT (*Fig. 19*) showed that the root of the impacted third molar was oriented to the buccal, which permitted the roots of the second molar to slip by in a distolingual direction. However, this favorable result is not predictable unless there is a pre-treatment CBCT. In general, third molar extraction should be performed before starting orthodontic treatment to retract the entire arch.¹²⁻

¹⁴ Fortunately, the current case had a favorable



■ Fig. 18:

Compared to pre-treatment (27yr 4mo), both maxillary second molars are tipped distally at the end of treatment (29yr 5mo). The left side appears to be due to the impacted third molar. The lower left second molar was uprighted but its axial inclination is WNL.



■ Fig. 19:

A CBCT view of the impacted lower left 3rd molar reveals that its root is oriented to the buccal, thereby allowing the second molar roots to move in a distolingual direction. This anatomical aberration appears to account for the lack of severe tipping when the left second molar was retracted (Figure 18).

outcome and the 3rd molars can be extracted after orthodontics treatment (Fig. 19), which is the usual preference for most patients.

Another important consideration is to agree to an alternate treatment plan if one or more of the IZC TADs fail. Before starting treatment, patients should sign a consent form specifying the treatment alternative(s). If an IZC bone screw fails, it may be possible to successfully place another TAD in an adjacent location, but if that is unsuccessful, extraction treatment and/or extensive IPR may be the only reliable options.

Conclusion

Extra-Alveolar (E-A) bone screws provide reliable anchorage for whole arch retraction. The infrazygomatic crest (IZC) bone screws are E-A TADs that are located buccal to the maxillary molar roots, so they do not interfere with retraction of the entire arch, to correct excessive overjet and Class II buccal segments. In addition, IZC bone screws are reliable anchorage for Class III elastics to retract the lower dentition to correct incisal flaring, whether it is a manifestation of the original malocclusion or a side effect of the mechanics to level and align the lower arch. In addition to its role in correcting Bolton discrepancies, interproximal enamel reduction is a viable alternative to extraction of permanent teeth, particularly when combined with full arch retraction. E-A bone screws are emerging as effective anchorage for the conservative management of challenging malocclusions that previously required extractions and/or orthognathic surgery. As documented in this report, IZC TADs are effective for the differential retraction of both arches at the same time.

References

1. Zhang N, Bai Y, and Li S. Treatment of a Class II Division 1 malocclusion with miniscrew anchorage. *Am J Orthod Dentofacial Orthop* 2012;141:e85-e93.
2. Lin JJ. A new method of placing orthodontic bone screws in IZC. *News & Trends in Orthodontics* 2009;13:4-7.
3. Lin JJ. *Creative Orthodontics: Blending the Damon system & TADs to manage difficult malocclusions*. 2nd ed. 2010; Yong Chieh Enterprise Co, Ltd., Taiwan. p. 187-207.
4. Kurth J, Kokich V. Open gingival embrasures after orthodontic treatment in adults; Prevalence and etiology. *Am J Orthod Dentofacial Orthop* 2001;120:116-23.
5. Tarnow, DB, Magmer, AW, Fletcher, P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *J Periodontol* 1992;63:995-96.
6. Frindel C. Clear thinking about interproximal stripping. *J Dentofacial Anom Orthod* 2010;13:187-99.
7. Zachrisson BU, Minster L, Ogaard B, Birkhed D. Dental health assessed after interproximal enamel reduction: Caries risk in posterior teeth. *Am J Orthod Dentofacial Orthop* 2011;139:90-8.
8. Germec D, Taner TU. Effects of extraction and nonextraction therapy with air - rotor stripping on facial esthetics in postadolescent borderline patients. *Am J Orthod Dentofacial Orthop* 2008;133:539-49.
9. Jung MH. A comparison of second premolar extraction and mini-implant total arch distalization with interproximal stripping. *Angle Orthod* 2013;83:680-5.
10. Bolton WA. The clinical application of a tooth-size analysis. *Am J of Orthod* 1962;48:504-29.
11. Barbara WS, Joanna JO, Piotr S. Overall and anterior bolton ratio in Class I, II and III orthodontic patients. *Eur J Orthod* 2010;32:313-18.
12. Kim TW, Artun J, Behbehani E, Artese F. Prevalence of third molar impaction in orthodontic patients treated nonextraction and with extraction of 4 premolars. *Am J Orthod Dentofacial Orthop* 2003;123:138-45.
13. Janson G, Putrick LM, Henriques JF, de Freitas MR, Henriques RP. Maxillary third molar position in Class II malocclusions: the effect of treatment with and without maxillary premolar extractions. *Eur J Orthod* 2006;28:573-79.
14. Southard TE, Southard KA, Weeda LW. Mesial force from unerupted third molars. *Am J Orthod Dentofacial Orthop* 1991;99:220-25.



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 = 4

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 = 4

CROWDING (only one arch)

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

Total = 4

OCCLUSION

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

Total = 4

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 2

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB $\geq 6^\circ$ or $\leq -2^\circ$ = 4 pts.

Each degree $< -2^\circ$ _____ x 1 pt. = _____

Each degree $> 6^\circ$ _____ x 1 pt. = _____

SN-MP

$\geq 38^\circ$ = 2 pts.

Each degree $> 38^\circ$ _____ x 2 pts. = _____

$\leq 26^\circ$ = 1 pt.

Each degree $< 26^\circ$ _____ x 1 pt. = _____

1 to MP $\geq 99^\circ$ = 1 pt.

Each degree $> 99^\circ$ 1 x 1 pt. = 1

Total = 1

OTHER (See Instructions)

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

Identify:

Total = 0

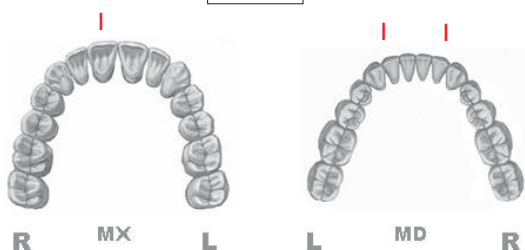
Cast-Radiograph Evaluation

Total CRE Score

17

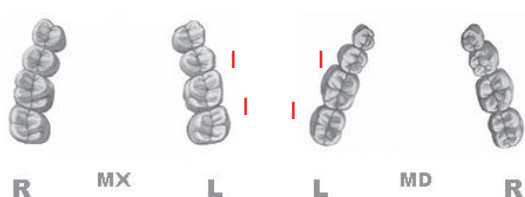
Alignment/Rotations

3



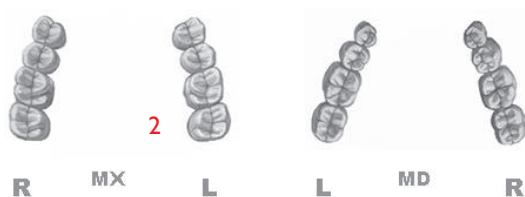
Marginal Ridges

4



Buccolingual Inclination

2



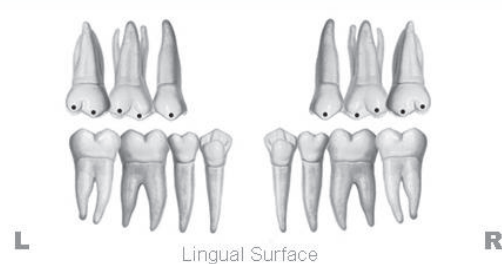
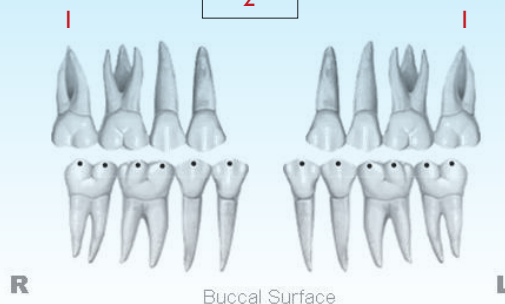
Overjet

0



Occlusal Contacts

2



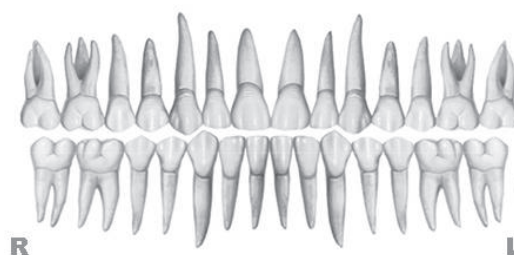
Occlusal Relationships

4



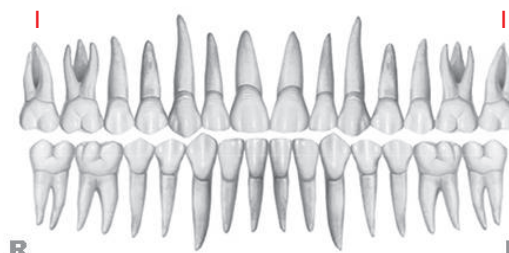
Interproximal Contacts

0



Root Angulation

2



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.