

# Interdisciplinary Treatment for a Mutilated Malocclusion with Excessive Vertical Dimension and Bimaxillary Protrusion

## Abstract

*This case report describes the diagnosis and interdisciplinary treatment for an adult female with a mutilated (4 missing teeth), acquired malocclusion with a protrusive profile. The Discrepancy Index (DI) was 26. There were multiple residual root tips in the edentulous spaces of the upper arch, and a compromised lower 3-unit fixed prosthesis. The lower dental midline was deviated to the right side ~3mm but there was no functional shift. The bimaxillary protrusion was corrected by closing space in both arches utilizing OrthoBoneScrew® anchorage. An edentulous site was prepared to restore the upper left 2<sup>nd</sup> premolar (#13) with an implant-supported prosthesis. Following orthodontics treatment, periodontal surgery was performed to correct soft tissue relationships in the maxillary anterior segment. Tooth #13 (UL 2<sup>nd</sup> premolar) was restored with an implant-supported prosthesis. The final outcome for the malocclusion was very good as documented by a Cast-Radiograph Evaluation (CRE) score of 26, and an excellent Pink & White dental esthetic score of 1. (Int J Othod Implantol 2015;38:22-48)*

### Key words:

*bimaxillary protrusion, passive self-ligating appliance, periodontal surgery, osteoplasty, ostectomy, flapless implant surgery, implant-supported prosthesis, IZC&buccal shelf screws*

## History and Etiology

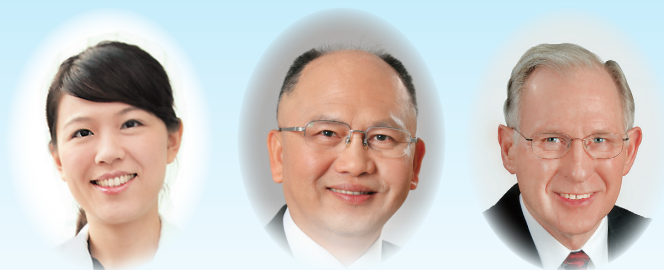
A 29-year 11 month female presented with chief complaints of a protruded profile, missing teeth and multiple residual roots and root tips (Figs. 1-3). The dental history revealed four missing teeth (#3, 13, 14 and 19). A missing lower left 1<sup>st</sup> molar (#19) was restored with an ill-fitting 3-unit fixed prosthesis (#18-20). Tooth #1 was extruded, tooth #2 was in lingual crossbite, and tooth #23 was in anterior crossbite. There was no contributing medical history. Pre-treatment photographs showed a generalized pattern of exostoses along the facial surface of the maxillary arch, a bimaxillary protrusive profile, an excessive lower facial height, a chin point deviated to the left, and a 3mm midline discrepancy with the mandible to the left (Figs. 1-3). Also noted were multiple interdental spaces in the upper arch, including a midline diastema, and unbalanced crown proportions for maxillary incisors.

The patient was treated to a pleasing result as shown in Figs. 4-6. Lateral cephalometric and panoramic radiographs document the pre-treatment condition (Fig. 7) and the post-treatment outcome (Fig. 8). Dentofacial management is documented with superimposed cephalometric tracings (Fig. 9).

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■ Fig. 1: Pre-treatment facial photographs



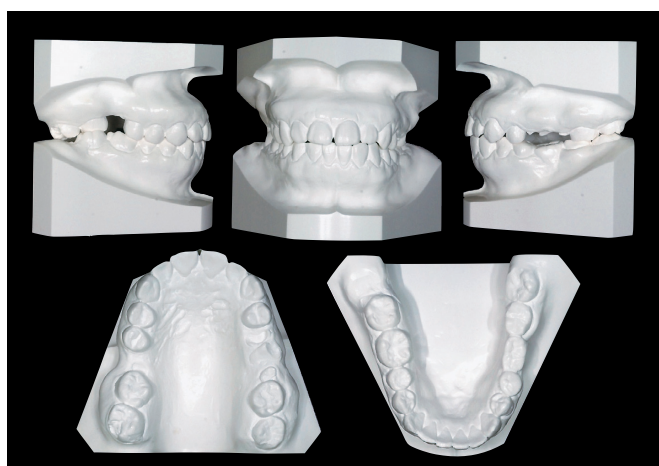
■ Fig. 4: Post-treatment facial photographs



■ Fig. 2: Pre-treatment intraoral photographs



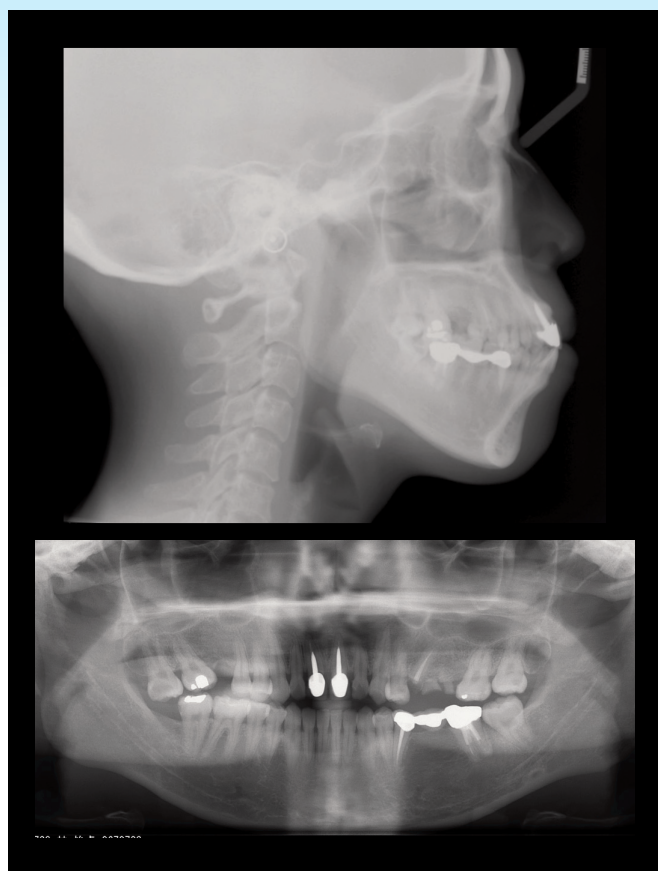
■ Fig. 5: Post-treatment intraoral photographs



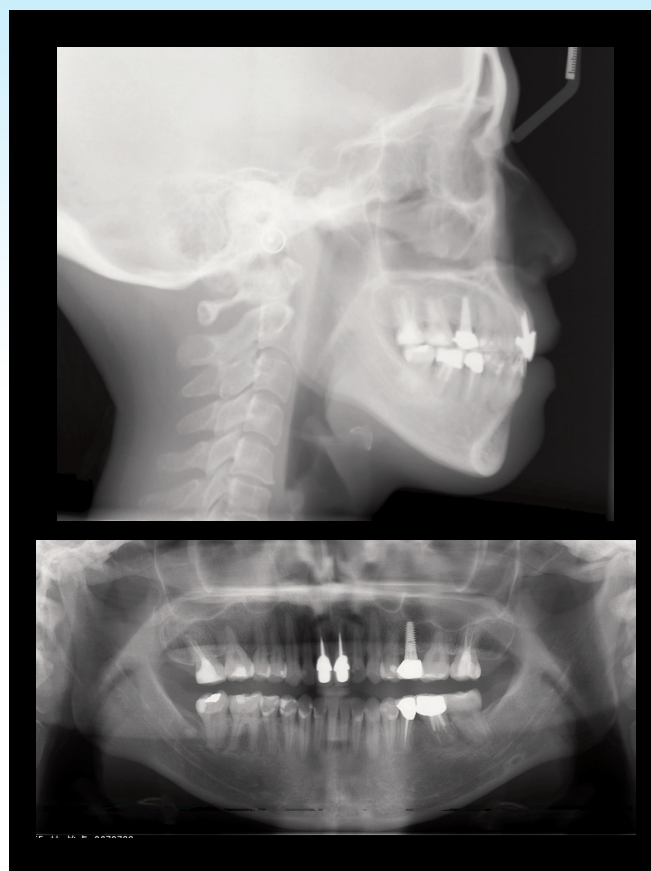
■ Fig. 3: Pre-treatment study models (casts)



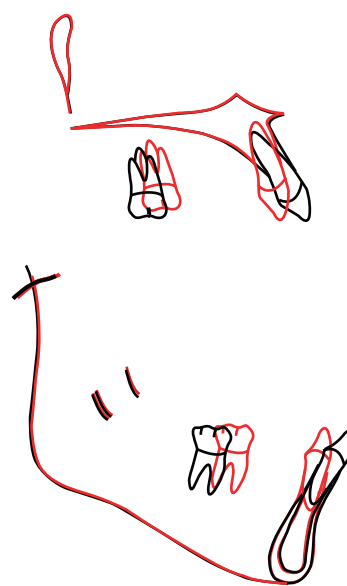
■ Fig. 6: Post-treatment study models (casts)



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



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



■ Fig. 9:  
Pre-treatment (black) and post-treatment (red) cephalometric tracings were superimposed on the anterior cranial base (left), maxilla (upper right) and mandible (lower right).

| CEPHALOMETRIC     |        |         |        |
|-------------------|--------|---------|--------|
| SKELETAL ANALYSIS |        |         |        |
|                   | PRE-Tx | POST-Tx | DIFF.  |
| SNA°              | 87°    | 86°     | 1°     |
| SNB°              | 80°    | 79°     | 1°     |
| ANB°              | 7°     | 7°      | 0°     |
| SN-MP°            | 40°    | 39°     | 1°     |
| FMA°              | 31°    | 30°     | 1°     |
| DENTAL ANALYSIS   |        |         |        |
| U1 TO NA mm       | 5 mm   | 0 mm    | 5 mm   |
| U1 TO SN°         | 105°   | 89°     | 16°    |
| L1 TO NB mm       | 11 mm  | 5 mm    | 6 mm   |
| L1 TO MP°         | 95°    | 78°     | 17°    |
| FACIAL ANALYSIS   |        |         |        |
| E-LINE UL         | 1.5 mm | -1 mm   | 2.5 mm |
| E-LINE LL         | 3.5 mm | 0 mm    | 3.5 mm |

Table 1: Cephalometric summary

## Diagnosis

### Skeletal:

- Skeletal Class II ( SNA 87°, SNB 80°, ANB 7°)
- High mandibular plane angle (SN-MP 40°, FMA 31°)
- Generalized maxillary exostoses on the facial surface

### Dental:

- Molar classification: *There were no first molars in occlusion, but overall the interdigitation was consistent with a Class I relationship, except for Class II right 2<sup>nd</sup> and 3<sup>rd</sup> molars (Fig. 3)*
- Canine relationship: *Bilateral Class I*
- Anterior crossbite: *Lower left lateral incisor*
- Posterior crossbite: *Upper right second molar in lingual crossbite*

- Lower dental midline: *Deviated to left 3mm, but no functional shift was evident*
- Residual roots and root tips: *upper right first molar, left second premolar and first molar (#3, 13, and 14)*
- Lack of symmetrical tooth proportion: *All maxillary incisors (#7-10)*
- Diastema: *Between the prosthetic crowns on the upper central incisors (Fig. 1).*

### Facial:

- Skeletal bimaxillary protrusion with excess vertical dimension of occlusion (VDO)
- Protrusive upper and lower lips.
- Facial asymmetry: *The chin point was deviated to the left side.*

The ABO Discrepancy Index (DI) was 26 as shown in the subsequent worksheet. The major discrepancies (11 points) were relative to cephalometrics (Table 1): excessive ANB angle and high mandibular plane (SN-MP angle).

## Treatment Objectives

After carefully reviewing the patient's facial profile, dental, and occlusal problems, the treatment objectives were as follows:

- Remove the residual roots and the pontic from the lower three-unit fixed prosthesis.
- Align the dentition, close spaces in both arches, and prepare an 8mm site for an implant to replace missing #13.
- Perform periodontal surgery to correct maxillary anterior soft tissue esthetic problems: *Crown lengthening of the incisors and reduction of the hypertrophic bony contours.*

- Restore area #13 with an implant-supported prosthesis (ISP).
- Establish normal overjet and overbite.
- Create a balanced occlusal relationship.

The overall clinical objectives were to restore occlusal function and improve smile esthetics with interdisciplinary treatment, involving orthodontics, periodontics, and an ISP.

### Treatment Alternatives

Two-jaw orthognathic surgery was considered because of multiple dental and skeletal problems: bimaxillary protrusive profile, excessive VDO, and deviated chin point. However, once the surgery was completed, it would still be necessary to restore the edentulous spaces. Although this approach may be the most predictable option for optimal facial esthetics, the patient rejected it because of the surgical morbidity, and increased cost for the surgery, plus the need for additional ISPs and/or other prostheses.

### Treatment Plan and Sequence

1. Full fixed orthodontic appliance
2. Bite turbos with a cross elastic to correct the upper right posterior crossbite
3. Insert OrthoBoneScrews® (OBSs)(Newton's A Ltd., Hsinchu City, Taiwan) as extra-alveolar temporary anchor devices, buccal to all first molar areas.
4. Use elastomeric chains or closed coil springs to

close space and reduce the profile.

5. Develop an implant site in the #13 area, and use a flapless surgical approach to place the implant.
6. Perform periodontal surgery in the maxillary anterior region to correct clinical crown proportions and reduce the osseous excess on the labial aspect of the maxilla.
7. Fabricate a final prosthesis six months after periodontal surgery and implant placement.
8. Retention of both arches with clear overlay retainers.

### Appliances and Treatment Progress

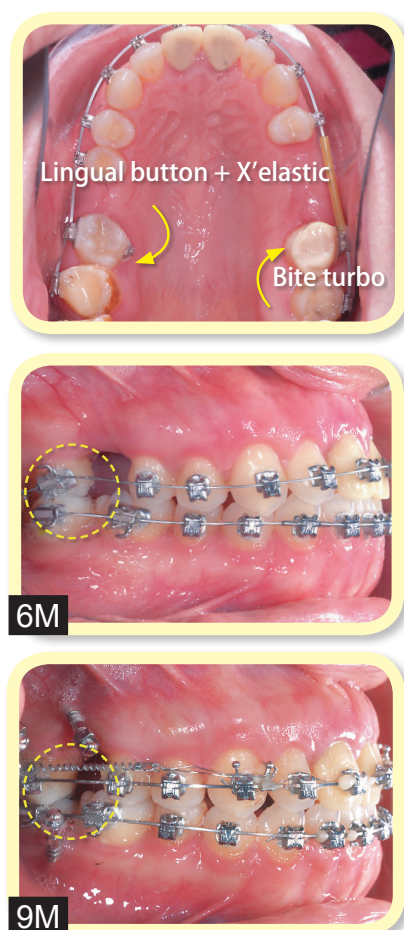
Damon MX3® 0.22" brackets (Ormco, Glendora, CA) were selected, utilizing high torque in the maxillary anterior and low torque in the mandibular anterior regions. The upper arch was bonded initially, and one month later the lower arch was bonded at the same appointment when anterior bite turbos were placed (Fig. 10) to facilitate correction of the anterior crossbite tendency. The upper and lower archwires were 0.016 CuNiTi.



■ Fig. 10:

Bite turbos were bonded on the lingual surfaces of the lower left lateral incisor and cuspid.

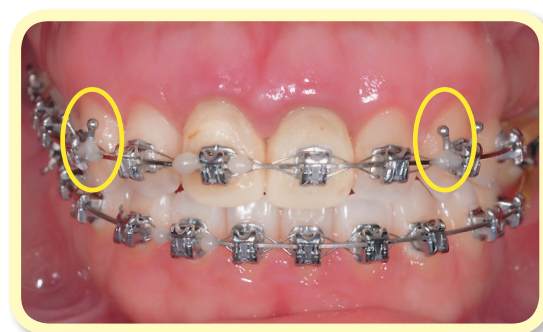
In the 6<sup>th</sup> month of treatment, the upper and lower archwires were changed to 0.014x0.025" CuNiTi. A bite turbo was bonded on the occlusal surface of upper left posterior second molar and a lingual button was bonded on the upper right second molar (#2). A crossbite elastic was attached from tooth #2 to the buccal surface of tooth #31. Three months later (9<sup>th</sup> month of treatment) the posterior lingual crossbite was corrected (Fig. 11).



■ Fig. 11:

In the upper occlusal view, the mechanics are shown for correcting a posterior lingual crossbite: lingual button with a cross elastic on the affected side and bite turbo on the opposite molar. Buccal views show the posterior crossbite before starting the correction, six months (6M) into treatment, and following 3 months of cross-elastic therapy to achieve a desired result, in the ninth month of treatment (9M) overall.

In the 10<sup>th</sup> month of treatment, a panoramic radiograph was used to evaluate all bracket positions relative to the axial inclinations of the teeth. The upper archwire was changed to 0.019x0.025" SS, and 2 crimped hooks were positioned bilaterally on the upper archwire between the lateral incisors and canines. The latter were used to connect closed coil springs and/or elastics to retract the anterior segment to close space (Figs. 12-14). The lower archwire was changed to 0.017x0.025" TMA.



■ Fig. 12:

Two crimped hooks (circled) between upper lateral incisors and canines were used as the anterior attachments bilaterally for elastometric chains from the OBSs to retract the anterior segment.



■ Fig. 13:

Extra-alveolar bone screws were inserted buccal to the molars in all four quadrants.



■ Fig. 14:

Both bone screws and posterior teeth served as the anchorage to retract the anterior teeth.

In the 12<sup>th</sup> month of treatment, 2x12 mm OBSs were inserted into the upper infrazygomatic crests and the lower buccal shelves, bilaterally (Fig. 13). Elastomeric chains were activated from the canines to the maxillary posterior bone screws to assist in retracting the upper anterior teeth to close space (Fig. 14). The lower bone screws were used to retract the lower dentition, and the bone screw on the lower left side was also used to protract the second and third molars.

In the 22<sup>nd</sup> month of treatment, the overjet was nearly edge to edge (Fig. 15). The lower bone screws were removed and Class III elastics were used from the lower first premolars to the upper second molars to correct the Class III occlusal relationship(s). To resist side effects on the lower arch, due to the Class III elastics and the elastomeric chains, the lower archwire was changed to 0.019x0.025" pre-torqued



■ Fig. 15:

The overjet was nearly edge to edge in the 22<sup>nd</sup> month of treatment (22M), so the lower bone screws were removed and Class III elastics were applied.

CuNiTi. The upper archwire was expanded to correct the right posterior crossbite tendency.

In the 25<sup>th</sup> month of treatment, the lower arch space was almost closed and the overbite was satisfactory (Fig. 16).



■ Fig. 16:

In the 25<sup>th</sup> month of treatment, the overjet was normal and the lower arch space had been closed.

In the 29<sup>th</sup> month of treatment, the upper archwire was changed to 0.019x0.025" SS and it was expanded in the posterior. Class III elastics were used from the upper OBSs to the hooks on the lower archwire.

In the 35<sup>th</sup> month of treatment, finishing (*vertical*) elastics were used in the molar areas bilaterally, to achieve an optimal occlusal interdigitation.

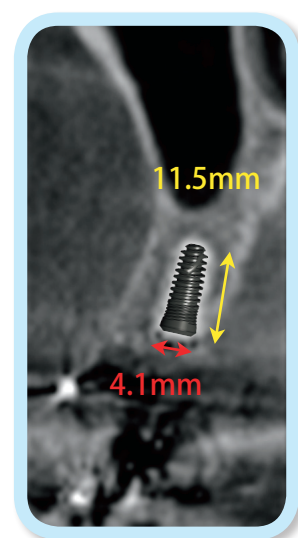
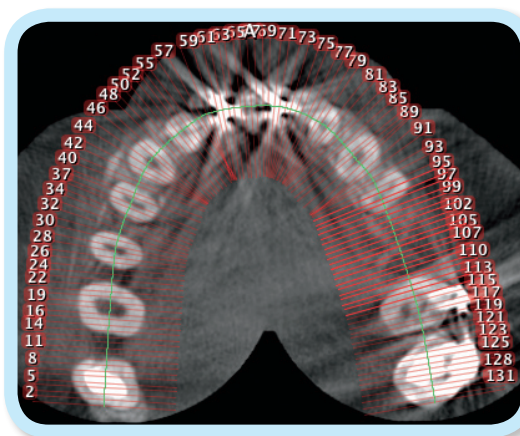
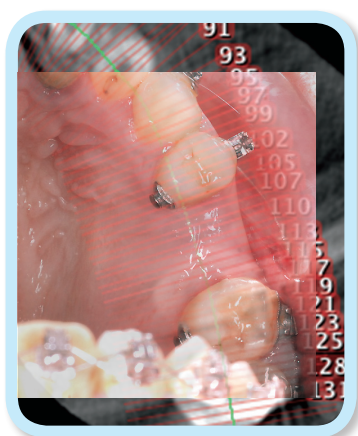
After 40 months of orthodontic treatment, all residual space was closed, except for an 8mm wide site for an implant in the upper left posterior area.

### Implant Placement

At the 43<sup>rd</sup> month of orthodontics treatment, preprosthetic records were collected, and the casts were used to fabricate the surgical stents to place an implant in the area of tooth #13 (Fig. 17). A preoperative Cone-Beam Computed Tomography (CBCT) scan was used to evaluate the alveolar bone volume in the implant site (Fig. 18). The bone



■ **Fig. 17:**  
The presurgical cast was used to fabricate the surgical stent.

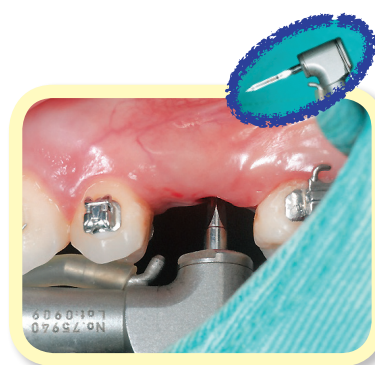


■ **Fig. 18:**  
CBCT imaging demonstrated that the bone width and height were adequate for a 4.1x11.5mm implant fixture.

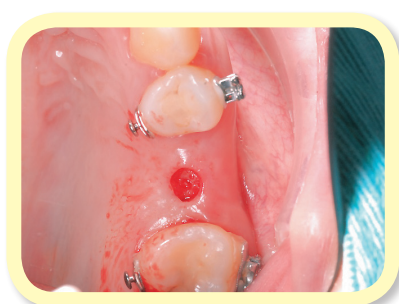
width and height were adequate for a 4.1x11.5 mm implant fixture. A flapless surgical approach was performed. After cutting the planned soft tissue emergence with a tissue punch, a circular incision was made and the soft tissue core was removed with a surgical curette to expose the crestal bone. A probe was used to check if there was 3 mm of distance between the crestal bone level and the surface of the soft tissue. Confirming this dimension is important for estimating the projected crown margin (Fig. 19). The 2B-3D rule<sup>1</sup> for dental implant planning, placement and restoration was followed.

After drilling to the proper depth with a lancer drill (Fig. 20), a surgical guide was inserted, and a periapical radiograph demonstrated that the osteotomy conformed to the planned position and orientation (Fig. 21). The osteotomy was enlarged

with twist drills to receive an Ø4.1X11.5mm, TwStar® (MegaGen® Taiwan) implant fixture, and a healing abutment were installed according to the manufacturer's recommendations (Fig. 22). A post-operative periapical radiograph confirmed the desired position and angulation of the implant. In addition, it was clear that the maxillary sinus membrane was not disrupted (Fig. 23).



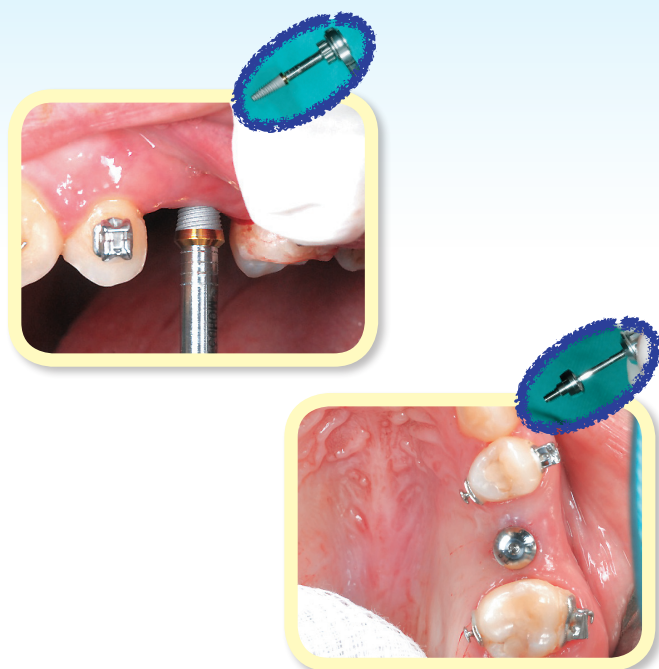
■ Fig. 20:  
The lancer drill prepared the initial osteotomy.



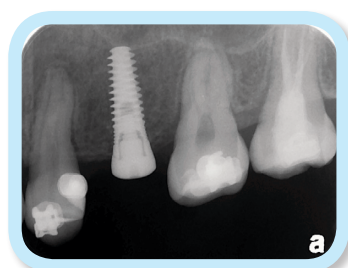
■ Fig. 19:  
The soft tissue thickness was measured to be 3mm before implant placement.



■ Fig. 21:  
A surgical guide pin was placed in the osteotomy and a periapical X-ray demonstrated the orientation of the implant site.



■ **Fig. 22:**  
After the implant fixture was inserted, the healing abutment was connected.



■ **Fig. 23:**  
A post-operative periapical X-ray was exposed to check the final position and angulation of the fixture.

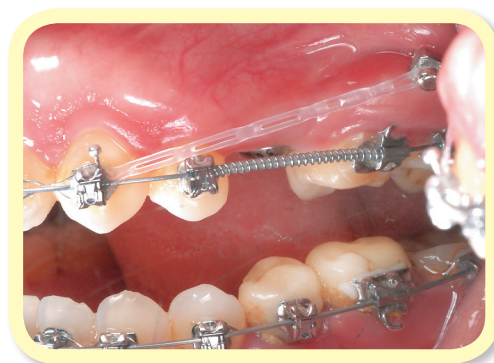
### Orthodontic Finishing Stage

After the implant was placed, orthodontics finishing was accomplished in the upper left quadrant by extending an elastomeric chain from the OBS to the canine. A coil spring was used to maintain space for the #13 implant as the molars were retracted (Fig.

24). At 50 months the finishing was complete (Fig. 25) so the patient was scheduled to have the fixed appliances removed. After debonding at 51 months, bone sounding was performed on the labial surfaces of the maxillary incisors (Fig. 26). The patient was scheduled for periodontal surgery and the implant prosthesis fabrication.

### Periodontic Surgery and Prosthesis Stage

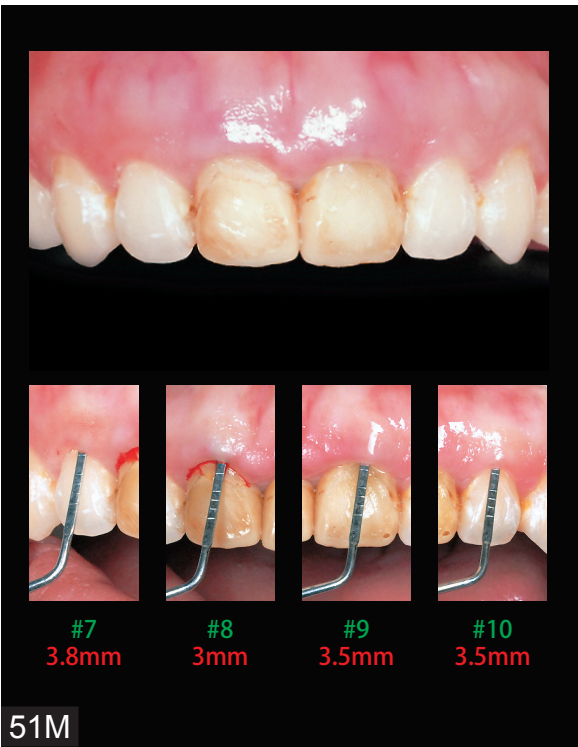
Following orthodontics treatment, all maxillary anterior teeth were retracted and intruded, resulting in adequate clinical crown exposures. Crown lengthening surgery was performed from teeth #7-10 to improve the esthetic proportions (*width and length*) of the incisor clinical crowns. Bone sounding was performed and the distances from the crestal bone to the gingival margin were 3.8mm, 3mm, 3.5mm, 3.5mm, respectively. The initial surgery was a gingivectomy, performed from teeth #7-#10 to reduce pocket depth (Fig. 26).<sup>2</sup> After 1 month of healing, new temporary crowns were placed on the maxillary central incisors (Fig. 27).



■ **Fig. 24:**  
The bone screw serves as anchorage to adjust the midline while the open coil spring moves the molar distally.



■ Fig. 25:  
Intraoral photos were taken 1 month before the end of active orthodontic treatment.



■ Fig. 26:  
The bone sounding, performed on all maxillary incisors, demonstrated excessive gingival height, so a gingivectomy was needed.



■ Fig. 27:  
One month after the gingivectomy, new temporary crowns were fabricated and adjusted for the central incisors.

Five months after the gingivectomy, the patient was unhappy with the bony prominence and gingival contours (*scalloping*) of the anterior maxillary region (Fig. 28), so a second periodontal surgical procedure was performed. The labial gingiva was reflected for an ostectomy and osteoplasty procedure<sup>3</sup> to reduce the excessive contours of the alveolar process and lengthen the clinical crowns of the incisors. The goal of this approach was to modify the bone

and gingival architecture (Fig. 29) to reduce the apparent gingival bulk and provide a more pleasing scalloping of the gingiva margins. The ostectomy was performed on the facial (*labial*) surface, to



■ **Fig. 28:**  
Following the gingivectomy and new temporary crowns, anterior esthetics were still inadequate.



■ **Fig. 29:**  
Ostectomy and osteoplasty were performed to correct the bony architecture.

achieve a uniform 2mm distance between the cemento-enamel junction (CEJ) and the alveolar bone crest to produce a more ideal scalloping of the gingival margins. Osteoplasty was performed to reduce the thickness of the alveolar bone under the soft tissue on the labial surface of the anterior segment.

Following 6 months of healing, the final prosthesis for the maxillary incisors was delivered (Fig. 30).



■ **Fig. 30:**  
The final prosthesis was finished, following 6 months of postoperative follow-up, which was 62 months (62M) from the start of interdisciplinary treatment.

## Implant Prosthesis Fabrication

The implant, placed in the area of #13 during the course of orthodontics treatment (Figs. 17-23), was restored after the appliances were removed. The implant healing abutment was removed and a multi-post abutment was selected for the prosthesis fabrication. The abutment was then modified with a diamond bur, mounted on a high speed handpiece, to accommodate occlusal function, while maintaining a desirable soft tissue contour. The post height of the abutment was reduced to provide 2mm of occlusal clearance for the fabrication of the porcelain fused to metal crown (Fig. 31).



■ **Fig. 31:**

After removing the healing abutment, the prosthetic abutment was connected to the fixture and adjusted to provide 2mm of clearance for fabrication of a porcelain fused to metal crown. In the right view, the black mark on the abutment will be removed to establish the appropriate clearance (2mm).

Before making the impression, abutment screws were torqued to 35N-cm with a screw driver and a torque ratchet (Fig. 32). A gingival retraction cord was positioned in the peri-implant sulcus with a packing-placement instrument (Fig. 33). A direct impression was obtained with polyvinyl siloxane (Fig. 34), and poured with type IV dental stone. The casts were subsequently articulated using appropriate check-bite records. A metal coping was fabricated by a commercial laboratory, and the marginal integrity of the casting was verified with a dental explorer.



■ **Fig. 32:**

Before making the impression, the abutment screws were torqued to 35-N-cm with a torque ratchet.



■ **Fig. 33:**

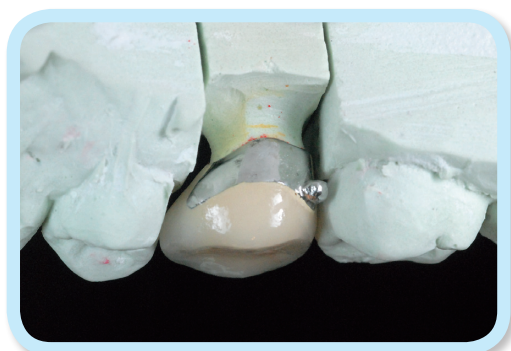
Gingival retraction cord was positioned in the peri-implant sulcus with a packing-placement instrument.



■ **Fig. 34:**

A direct impression was obtained with polyvinyl siloxane.

After completion of the crown the contact area was tested with dental floss (Fig. 35). After verification of the fit and clinical adjustment of the occlusion, the permanent crown was luted with temporary cement (Fig. 36).



■ **Fig. 35:**  
The completed final prosthesis is checked for occlusion and interproximal contact.

In the final stages of treatment (~62 mo), new crowns were delivered for teeth #18 and 20. These teeth were the previous abutments for the original lower 3-unit fixed prosthesis (Figs. 2, 3, 7 and 37). As previously mentioned, the pontic was removed and the space was closed orthodontically (Fig. 9).



■ **Fig. 36:**  
Left: the final prosthesis for the upper second premolar was luted into place.  
Right: the lower occluding restorations were still temporary crowns.



■ **Fig. 37:**  
The lower left prostheses were also finished in the 62<sup>th</sup> month of treatment.

## Results Achieved

### Maxilla (all three planes):

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

### Mandible (all three planes):

- A - P: *Retracted*
- Vertical: *Decreased by rotating the mandible counter-clockwise 1°*
- Transverse: *Maintained*

### Maxillary Dentition

- A - P: *Incisors retracted, molars protracted*
- Vertical: *Intrusion of the entire arch*
- Inter-molar / Inter-canine Width: *Maintained*

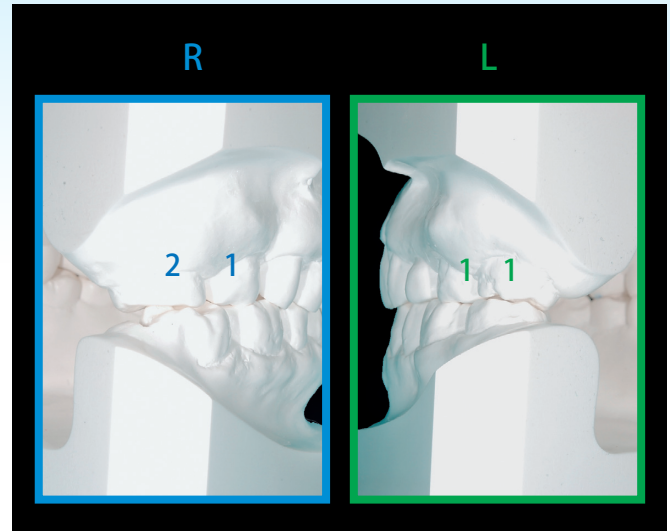
### Mandibular Dentition

- A - P: *Incisors retracted, molars protracted*
- Vertical: *Intruded*
- Inter-molar / Inter-canine Width: *Maintained*

Facial Esthetics: Lip protrusion reduced

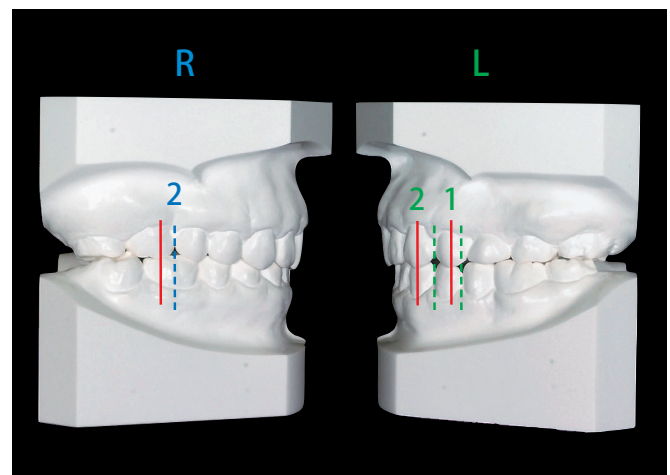
## Final Evaluation of the Treatment

The ABO Cast-Radiograph Evaluation (CRE) score was 26 points. The major discrepancies were 5 points each: posterior overjet (Fig. 38), occlusal relationships (Fig. 39) and occlusal contacts. The midline deviation was maintained because it was considered to be of skeletal origin, and orthodontic correction would probably be unstable. Note that the CRE scoring method does not deduct points for a midline



■ Fig. 38:

A major CRE discrepancy was posterior overjet (5 points). The score for each of the affected upper molars is shown.



■ Fig. 39:

Occlusal relationships were scored at 5 points as shown, during the CRE assessment.

discrepancy, because it is not a problem unless there is a compromise in the posterior occlusion. Details of the CRE scoring are presented in the scoring worksheet at the end of this report.

Overall, dental and facial esthetics were well managed. The Pink & White dental esthetics

score was 1, which is an excellent outcome. Facial esthetics were improved by decreasing the VDO and correcting the protrusive profile (Fig. 9). The latter was substantially reduced by using OBSs to retract the upper and the lower anterior segments. The smile esthetics were enhanced by periodontal surgery and custom fabrication of the final prostheses.

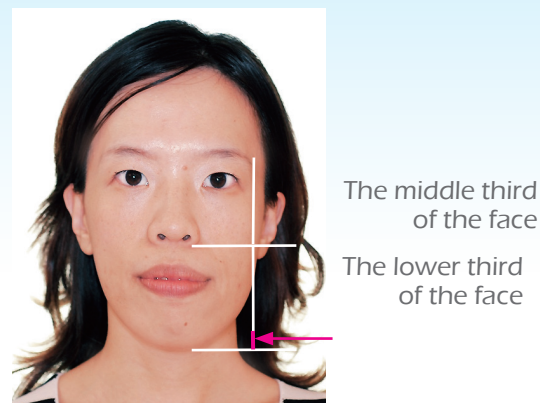
Occlusal function was considerably improved by removing residual roots, performing orthodontics to close space or redistribute it, and fixed prosthetics. Implant-Abutment Transition & Position Analysis achieved a very good score of 2, as documented by the worksheet at the end of this case report.

## Discussion

The diagnosis and treatment for the current patient was segmented into two distinct problems, relating to discrepancies in the vertical and sagittal planes.

### 1. Vertical:

With a natural smile, the patient had an excessive gingival display,<sup>4,6</sup> although it was not evident on the initial smiling view photo (Fig. 1). Skeletally, there was an excessive vertical dimension of occlusion (VDO). The lower third of her face, distance from subnasale to the lower border of the chin, exceeded the dimension of the middle third of the face, from glabella to subnasale (Figs. 1 and 40). Excessive gingival display is a descriptive term rather than a specific diagnosis.<sup>4</sup> Numerous anatomical and physiologic factors may interact for the visual perception of "excessive gingival display." A few examples are vertical maxillary excess,<sup>7</sup> delayed



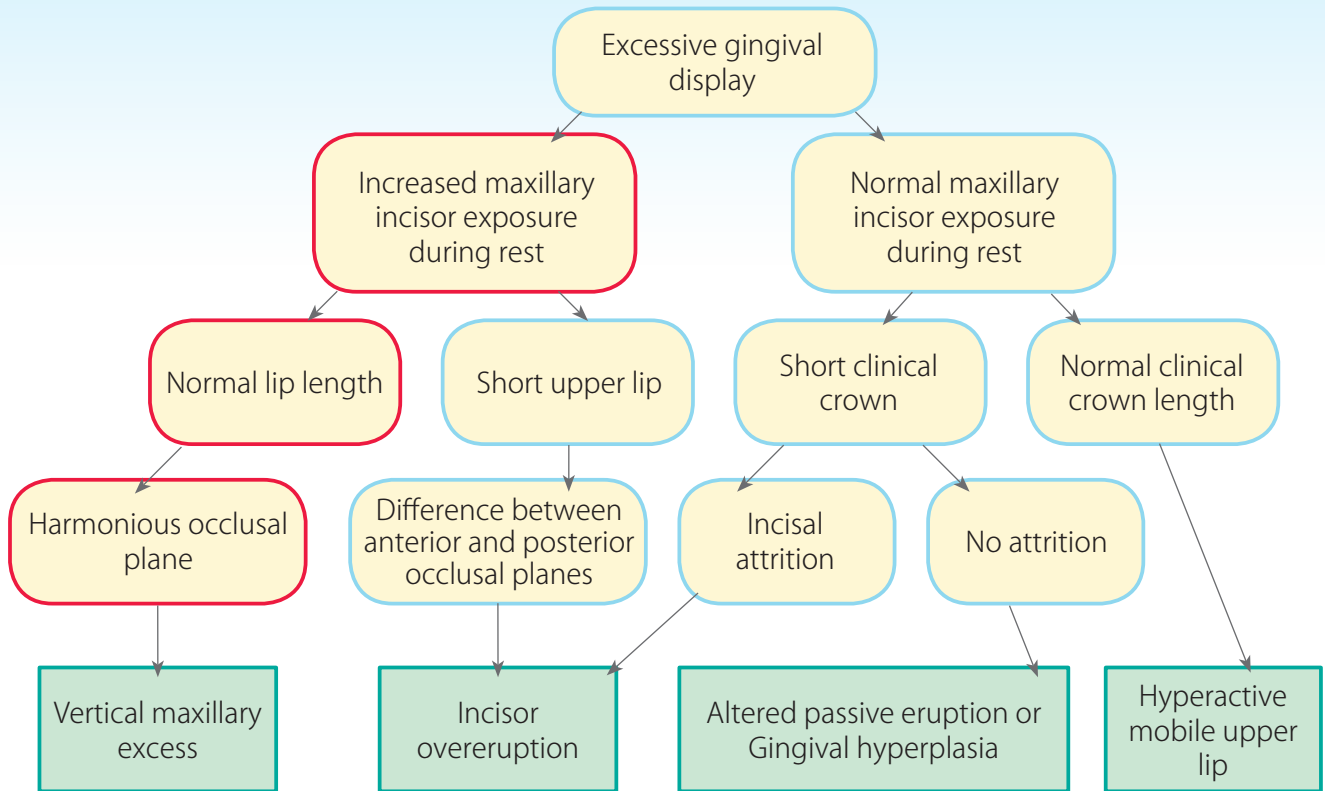
■ Fig. 40:

*Pretreatment, the lower third of the face is longer than the middle third. The red arrow and line show the lower facial excess.*

passive eruption,<sup>8,9</sup> abrasion of the anterior dentition with compensatory over eruption, short upper lip, hyperactive maxillary lip contraction and/or short anatomic crown. A flow chart (Fig. 41) was used for a systematic assessment<sup>7</sup> to arrive at the diagnosis for the current patient which was vertical maxillary excess with short anatomic crowns.

Gummy smile was not the patient's chief complaint, so she was not motivated for orthognathic surgery,<sup>6</sup> but she did desire a less invasive, interdisciplinary correction with orthodontics, periodontal surgery and prosthetics. Orthodontics treatment was needed to correct or at least improve the excessive VDO and lip protrusion. Thus, the appropriate treatment plan involved a specific sequence of interdisciplinary procedures.

Following the initial phase of orthodontic treatment, the length of the temporary crowns was adjusted (Fig. 42). Superimposed cephalometric tracings of the maxilla reveal that the maxillary incisors and molars were intruded (Fig. 43). Periodontal surgery was performed to correct the crown-to-



- Normal maxillary incisor exposure during rest: ~3-4 mm in young women, 2 mm in young men
- Normal lip length: 20~24 mm
- Normal crown length of maxillary central incisor: 10.5 mm

■ Fig. 41:

Using this flow chart, the etiology of the gingival display was determined to be vertical maxillary excess.<sup>7</sup> The path leading to this conclusion is marked in red.

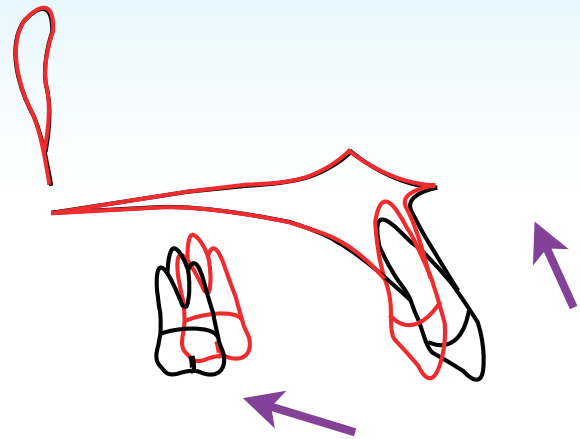
root ratio, gingival display, and bony contour of the anterior maxilla.<sup>10</sup> To improve predictability, a gingivectomy<sup>2</sup> was performed as the initial surgery, but the results failed to meet the patient's esthetic needs, so osteoplasty and ostectomy procedures were performed.<sup>3</sup> The osteoplasty reshaped the anterior maxillary without removing any tooth-supporting bone. In contrast, the ostectomy removed tooth supporting bone, to denude the upper roots of the incisors (Fig. 29). The goals for this combined procedure was to improve the gingival

scalloping architecture and decrease the protrusive appearance of the anterior maxilla. The ostectomy was performed on the labial surface of the incisors, to reduce the distance to 2mm from the CEJ to crest of the supporting alveolar bone. This relationship is consistent with biologic width for a healthy periodontium (Fig. 44). The osteoplasty reduced the thickness and improved the contour of the labial bone under the soft tissue. Finally, the crown root ratio was adjusted further by prosthodontic treatment.



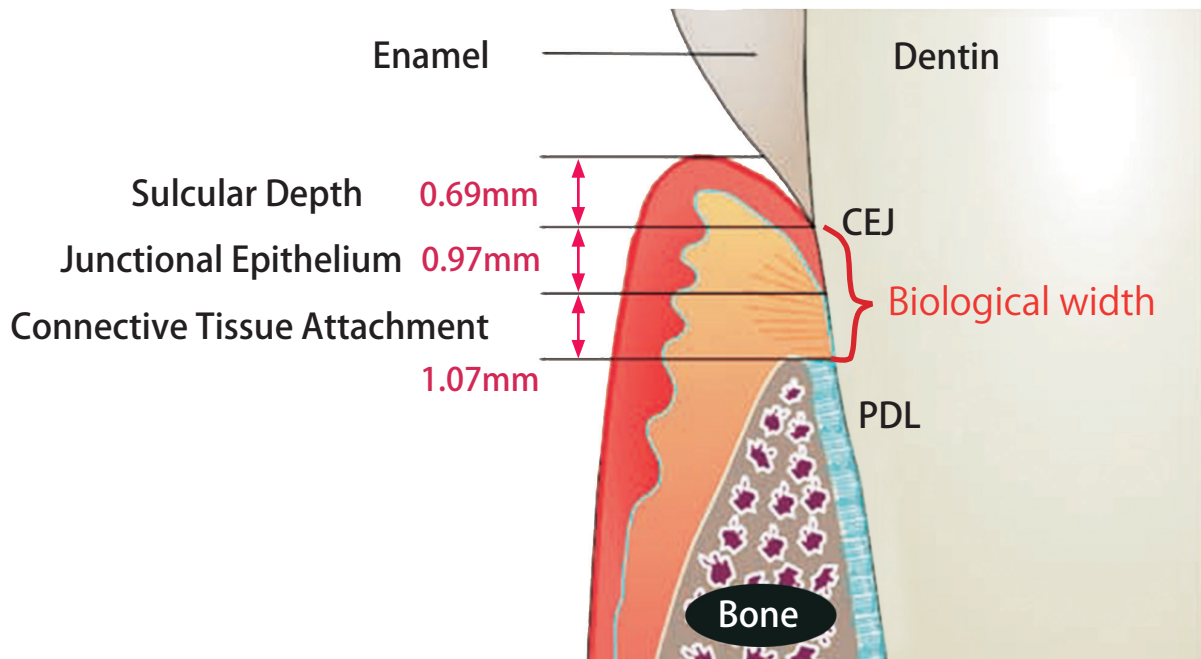
■ Fig. 42:

The maxillary incisor relationship is shown at the start of treatment (top) and after the temporary crowns were adjusted (bottom) following the termination of active orthodontic treatment.



■ Fig. 43:

The maxillary incisors and molars were intruded by orthodontic treatment as demonstrated by the purple arrows.



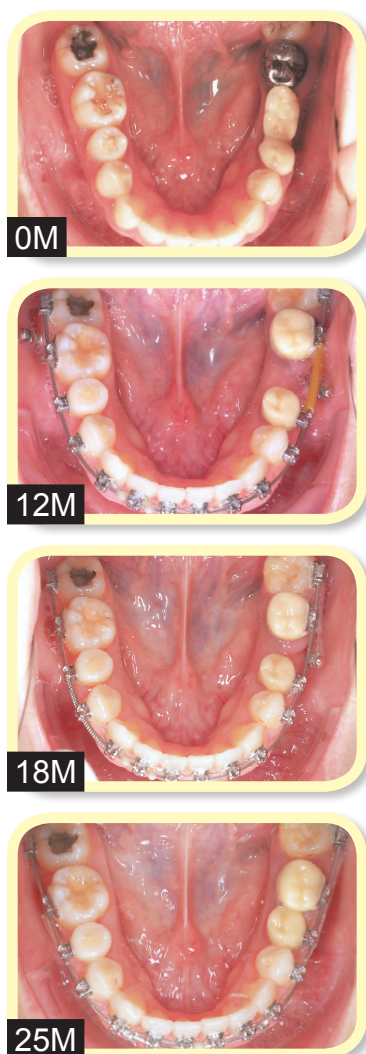
■ Fig. 44:

This diagram shows the morphology of an ideal biologic width when the alveolar crest is 2mm apical to the CEJ.<sup>7</sup>

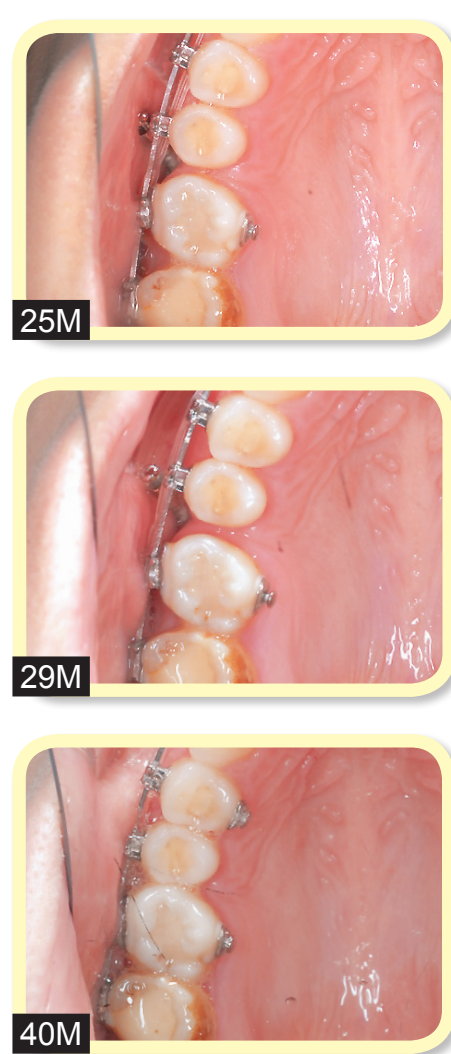
## 2. Sagittal:

Surprisingly, the space in the lower arch was closed in ~25 months (Fig. 45) while the upper arch required 40 months (Fig. 46). The conservative rate of space closure in the maxillary right quadrant may have been related to the bone atrophy in the edentulous implant site that was noted prior to treatment (Fig. 47).<sup>11</sup> Another sagittal issue was the

retraction of the lower right dentition, so in the 12<sup>th</sup> month of treatment a bone screw was inserted in the mandibular right buccal shelf. In the 18<sup>th</sup> month of treatment, the bone screw was removed and the patient was instructed to use Class III elastics from the lower right canine to the upper right first molar. After 7 months of elastics therapy, the Class



■ **Fig. 45:**  
Compared to the pretreatment lower occlusal view (0M), the progress of lower left space closure is shown after twelve (12M), eighteen (18M), and twenty-five (25M) months of treatment.

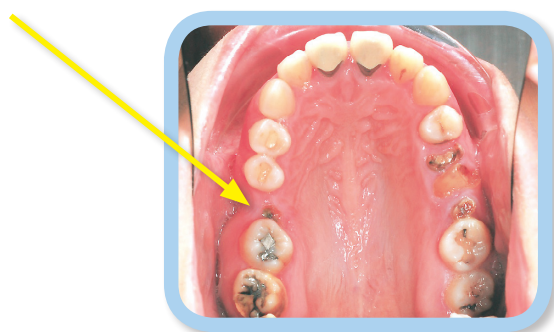


■ **Fig. 46:**  
The progress of upper right space closure is shown at twenty-five (25M), twenty-nine (29M), and forty (40M) months of treatment.

III occlusal relationship was corrected due to the Multiloop Edgewise Arch Wire (MEAW) effect<sup>12,13</sup> of the passive self ligating appliance (Fig. 48).

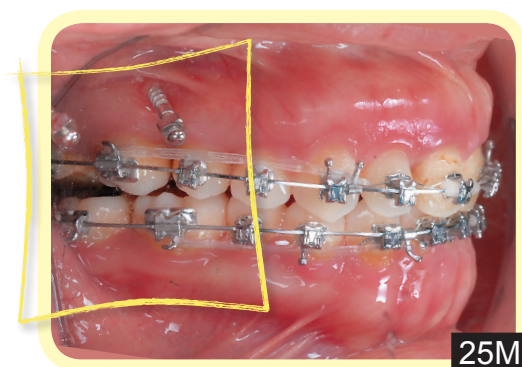
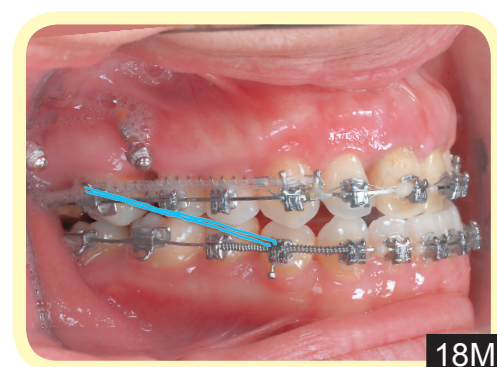
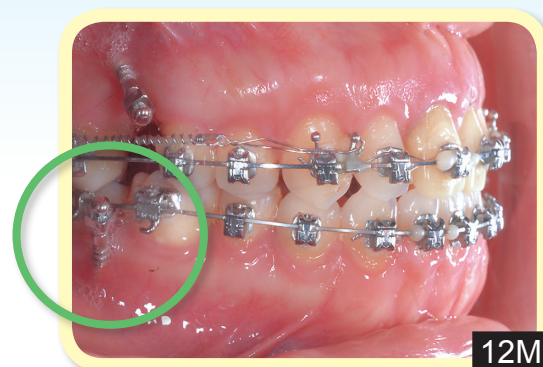
The third sagittal problem involved the need to extract a lower right premolar. This procedure helped resolve the midline discrepancy, retract the lips and reduce lower arch width to improve posterior overjet. However, a careful assessment of the dentition and face indicated the midline discrepancy was probably skeletal, and the incisors were sufficiently retracted (Fig. 49), so the decision was made to not extract the premolar. The patient was happy with this decision. Furthermore she was willing to accept the decreased posterior overjet, and wanted no further orthodontic treatment.

## Bone atrophy



■ Fig. 47:

At the start of treatment there was an area of bony atrophy was noted (arrow) that was associated with a retained root tip mesial to the second molar.



■ Fig. 48:

Retraction of the lower right dentition at 12 months (12M) was achieved by an OBS (green circle) as anchorage. At 18 months (18M) a Class III elastic (blue line) was used to correct the sagittal discrepancy on the right side. At 25 months (25M) of treatment the buccal occlusion has been corrected (yellow lines).

Pre-Tx



Post-Tx



|           | Pre-Tx | Post-Tx | DIFF.  |
|-----------|--------|---------|--------|
| U1 TO NA  | 5 mm   | 0 mm    | 5 mm   |
| U1 TO SN° | 105°   | 89°     | 16°    |
| L1 TO NB  | 11 mm  | 5 mm    | 6 mm   |
| L1 TO MP° | 95°    | 78°     | 17°    |
| E-LINE UL | 1.5 mm | -1 mm   | 2.5 mm |
| E-LINE LL | 3.5 mm | 0 mm    | 3.5 mm |

■ Fig. 49:

Before and after treatment, the axial inclinations are decreased for both the maxillary and mandibular incisors, as demonstrated by the differentials (Diff.) between the pre-treatment (Pre-Tx) and post-treatment (Post-Tx) cephalometric measurements.

## Conclusion

Overall, the treatment time was 62 months for the entire sequence of interdisciplinary procedures: orthodontics, implant placement, periodontal surgery, and prosthesis. The treatment sequence was complex involving the asymmetric closure of large spaces, differential tooth movement to create an optimal implant site, implant placement surgery, two periodontal surgeries, and three temporary prosthesis procedures. The final result was excellent (CRE 26) for the comprehensive management of a challenging mutilated dentition (DI 26). The patient and the clinicians were well satisfied with the result.

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## Discrepancy Index Worksheet

**TOTAL D.I. SCORE** 26
**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 = 0
**ANTERIOR OPEN BITE**

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

 Total = 1
**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 = 0
**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. _____ pts.<br>additional |

 Total = 0
**LINGUAL POSTERIOR X-BITE**

 1 pt. per tooth      Total = 1
**BUCCAL POSTERIOR X-BITE**

 2 pts. per tooth      Total = 0
**CEPHALOMETRICS** (See Instructions)

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

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

 Each degree  $> 6^\circ$  1 x 1 pt. = 1
**SN-MP**
 $\geq 38^\circ$  = 2 pts.

 Each degree  $> 38^\circ$  2 x 2 pts. = 4
 $\leq 26^\circ$  = 1 pt.

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

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

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

 Total = 11
**OTHER** (See Instructions)

|                                               |                                                                                  |
|-----------------------------------------------|----------------------------------------------------------------------------------|
| Supernumerary teeth                           | _____ x 1 pt. = _____                                                            |
| Ankylosis of perm. teeth                      | _____ x 2 pts. = _____                                                           |
| Anomalous morphology                          | _____ x 2 pts. = _____                                                           |
| Impaction (except 3 <sup>rd</sup> molars)     | _____ x 2 pts. = _____                                                           |
| Midline discrepancy ( $\geq 3$ mm)            | @ 2 pts. = <span style="color: red;">2</span>                                    |
| Missing teeth (except 3 <sup>rd</sup> molars) | <span style="color: red;">4</span> x 1 pts. = <span style="color: red;">4</span> |
| Missing teeth, congenital                     | _____ x 2 pts. = _____                                                           |
| Spacing (4 or more, per arch)                 | _____ x 2 pts. = <span style="color: red;">2</span>                              |
| Spacing (Mx cent. diastema $\geq 2$ mm)       | @ 2 pts. = _____                                                                 |
| Tooth transposition                           | _____ x 2 pts. = _____                                                           |
| Skeletal asymmetry (nonsurgical tx)           | @ 3 pts. = <span style="color: red;">3</span>                                    |
| Addl. treatment complexities                  | _____ x 2 pts. = _____                                                           |

Identify:

 Total = 11

## Cast-Radiograph Evaluation

Case #

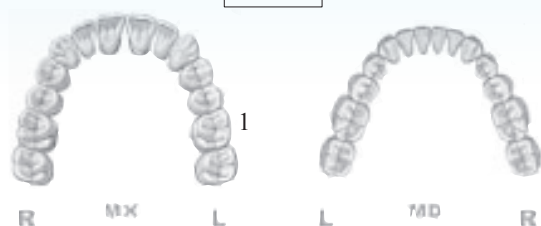
Patient

Total Score:

**26**

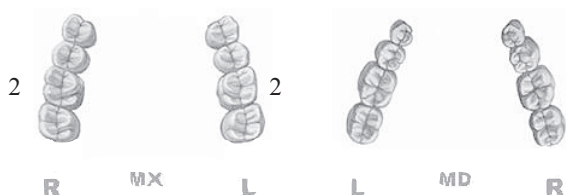
Alignment/Rotations

1



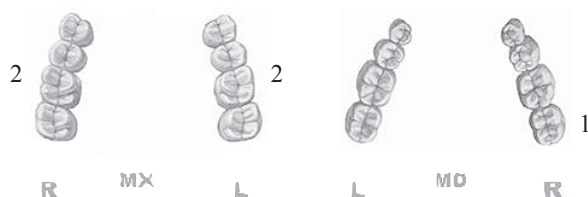
Marginal Ridges

4



Buccolingual Inclination

4



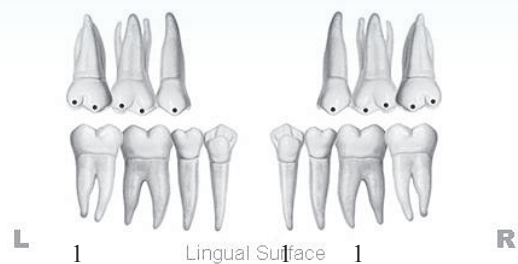
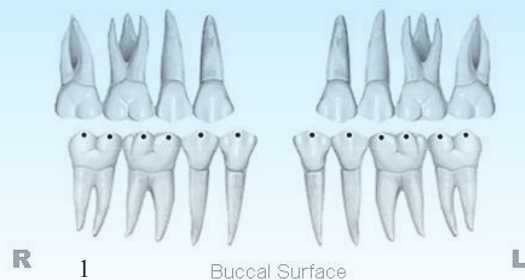
Overjet

5



Occlusal Contacts

5



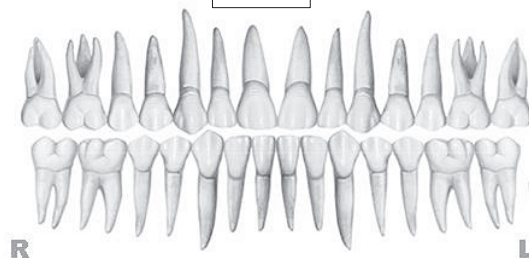
Occlusal Relationships

5



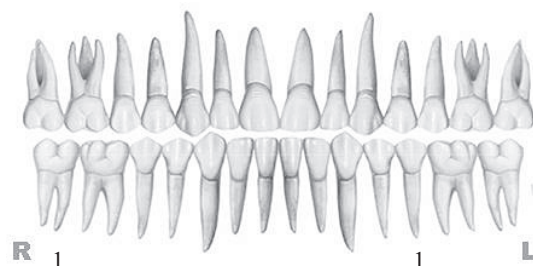
Interproximal Contacts

0



Root Angulation

2

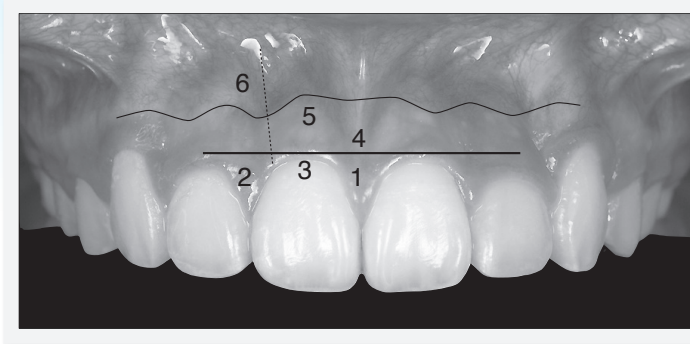


**INSTRUCTIONS:** Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 1

### 1. Pink Esthetic Score

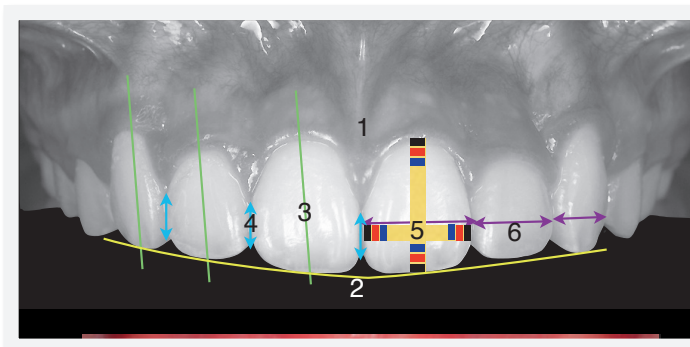


|                                 |   |   |   |
|---------------------------------|---|---|---|
| 1. Mesial Papilla               | 0 | 1 | 2 |
| 2. Distal Papilla               | 0 | 1 | 2 |
| 3. Curvature of Gingival Margin | 0 | 1 | 2 |
| 4. Level of Gingival Margin     | 0 | 1 | 2 |
| 5. Root Convexity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

|                                 |   |   |   |
|---------------------------------|---|---|---|
| 1. M & D 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 |

Total = 1

### 2. White Esthetic Score ( for Micro-esthetics )



|                                      |   |   |   |
|--------------------------------------|---|---|---|
| 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 |

Total = 0

## IBOI Pink & White Esthetic Score

### 1. Pink Esthetic Score

Total = 1



|                                 |                                                                                 |                                                                                 |   |
|---------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---|
| 1. M & D Papillae               | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 2. Keratinized Gingiva          | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 3. Curvature of Gingival Margin | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 4. Level of Gingival Margin     | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 5. Root Convexity ( Torque )    | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 6. Scar Formation               | 0                                                                               | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">1</span> | 2 |

### 2. White Esthetic Score ( for Single-implant )

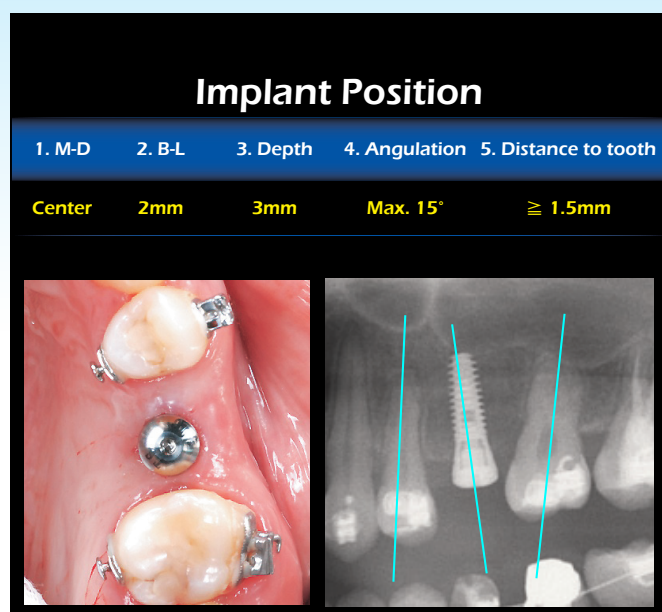
Total = 1



|                                 |                                                                                 |                                                                                 |   |
|---------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---|
| 1. Tooth Form                   | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 2. Mesial & Distal Outline      | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 3. Crown Margin                 | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 4. Translucency (Incisal third) | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 5. Hue & Value (Middle Third)   | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">0</span> | 1                                                                               | 2 |
| 6. Tooth Proportion             | 0                                                                               | <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">1</span> | 2 |

# Implant-Abutment Transition & Position Analysis

## 1. Implant Position

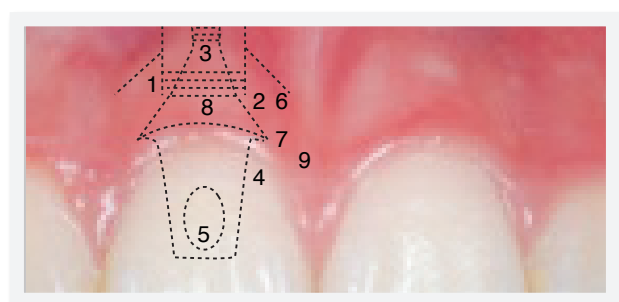


Total = **2**

|                                 |   |   |   |
|---------------------------------|---|---|---|
| 1. M & D ( Center )             | 0 | 1 | 2 |
| 2. B & L ( Buccal 2 mm )        | 0 | 1 | 2 |
| 3. Depth ( 3 mm )               | 0 | 1 | 2 |
| 4. Angulation ( Max. 15° )      | 0 | 1 | 2 |
| 5. Distance to Adjacent Anatomy | 0 | 1 | 2 |

|                                 |          |          |   |
|---------------------------------|----------|----------|---|
| 1. M & D ( Center )             | 0        | <b>1</b> | 2 |
| 2. B & L ( Buccal 2 mm )        | <b>0</b> | 1        | 2 |
| 3. Depth ( 3 mm )               | <b>0</b> | 1        | 2 |
| 4. Angulation ( Max. 15° )      | 0        | <b>1</b> | 2 |
| 5. Distance to Adjacent Anatomy | <b>0</b> | 1        | 2 |

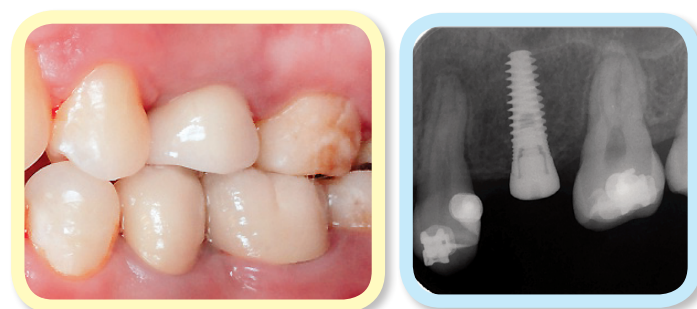
## 2. Abutment transition Contour



E : external connection,  
 I : internal connection,  
 S : screw type,  
 C : cement type,  
 P : palatal/central,  
 B : buccal

Total = **0**

|                              |   |   |   |   |   |
|------------------------------|---|---|---|---|---|
| 1. Fixture Cervical Design   | N | Y |   |   |   |
| 2. Platform Switch           | N | Y |   |   |   |
| 3. I-A Connection Type       | E | I |   |   |   |
| 4. Abutment Selection        | S | C |   |   |   |
| 5. Screw Hole Position       | P | B |   |   |   |
| 6. Marginal Bone Loss        | N | Y | 0 | 1 | 2 |
| 7. Modified Gingival Contour | N | Y | 0 | 1 | 2 |
| 8. Gingival Height           | N | Y | 0 | 1 | 2 |
| 9. Crown margin fitness      | N | Y | 0 | 1 | 2 |



|                              |   |   |   |     |
|------------------------------|---|---|---|-----|
| 1. Fixture Cervical Design   | N | Y |   |     |
| 2. Platform Switch           | N | Y |   |     |
| 3. I-A Connection Type       | E | I |   |     |
| 4. Abutment Selection        | S | C |   |     |
| 5. Screw Hole Position       | P | B |   |     |
| 6. Marginal Bone Loss        | N | Y | 0 | 1 2 |
| 7. Modified Gingival Contour | N | Y | 0 | 1 2 |
| 8. Gingival Height           | N | Y | 0 | 1 2 |
| 9. Crown margin fitness      | N | Y | 0 | 1 2 |