

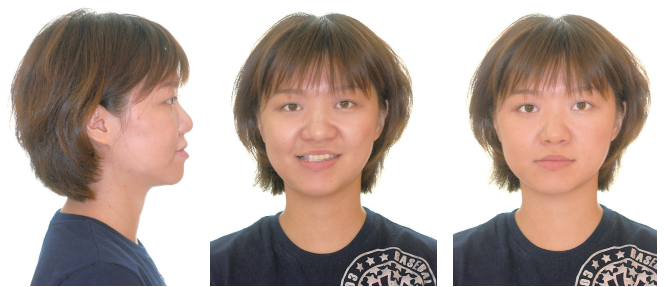
# A Class III Mutilated Malocclusion Treated with Orthodontics and an Implant-Supported Prosthesis

## History And Etiology

A 24 year old female was referred by her dentist for orthodontic consultation (Fig. 1). Her chief concern was difficulty in incising food and chewing with her posterior missing teeth (Figs. 2-3). There was no contributory medical history, but she had an extensive dental treatment history involving extractions, endodontics and multiple restorative procedures. To restore optimal occlusal function, an interdisciplinary treatment plan was proposed that included orthodontics, implant site preparation, an implant-supported prosthesis, and new crowns on the maxillary incisors. The patient was treated to an optimal result as documented in Figs. 4-9. The details of diagnosis and treatment will be discussed below.

## Diagnosis

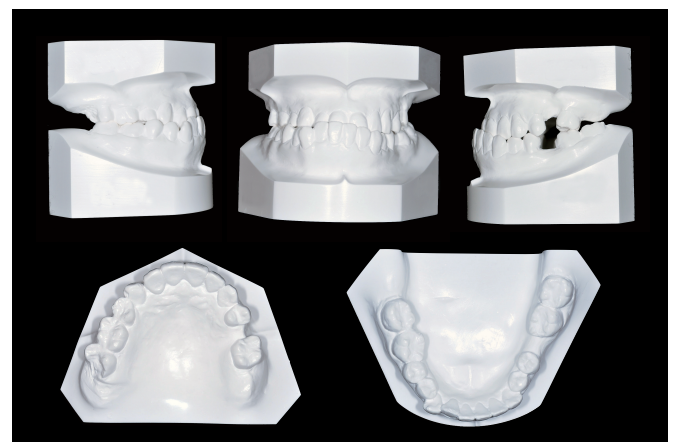
Cephalometric and panoramic radiographs (Fig. 7) document the complexity of the malocclusion. Following extraction of the maxillary right first molar, the second molar moved mesially and the maxillary sinus enlarged, so that there was inadequate alveolar bone to serve as an implant site. To place an implant-supported prosthesis in the maxillary right quadrant, a sinus lift bone graft or orthodontic site development is required.



■ Fig. 1: Pretreatment facial photographs



■ Fig. 2: Pretreatment intraoral photographs



■ Fig. 3: Pretreatment study models

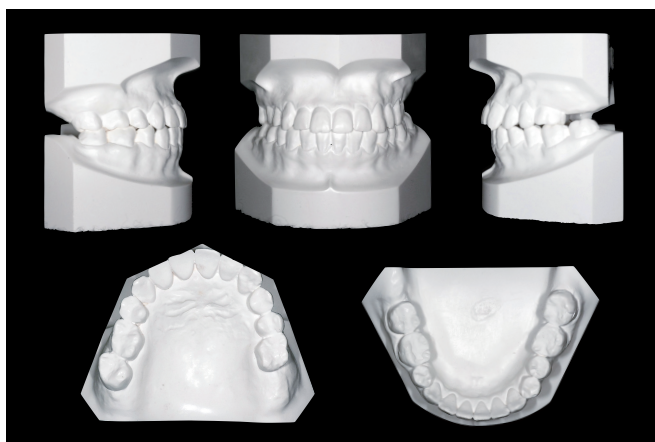
Dr. Yu Lin Hsu, Lecturer, Beethoven Orthodontic Course (right)  
 Dr. Chris HN Chang, Director, Beethoven Orthodontic Center (middle)  
 Dr. Eugene W. Roberts, Consultant,  
 International Journal of Orthodontics & Implantology (left)



■ Fig. 4: Posttreatment facial photographs



■ Fig. 5: Posttreatment intraoral photographs



■ Fig. 6: Posttreatment study models

#### Skeletal:

- Skeletal Class III ( $SNA\ 86^\circ$ ,  $SNB\ 87^\circ$ ,  $ANB\ -1^\circ$ )
- Insufficient bone height for implants in areas #13 & 15

#### Dental:

- Right Class I molar relationship
- Left Class III canine relationship
- Missing teeth #1, 5, 13, 15, 16, 19, 32
- Anterior cross bite of #6 - 10
- Posterior cross bite of #4
- Crowding in the mandibular arch
- Dental Midlines: maxillary 2mm right of the facial midline, mandibular 3mm right of the maxillary midline.
- Ill-fitting prostheses restoring #7, 8, 9, 10
- Incomplete endodontic treatment of #6

#### Facial:

- Straight profile with slightly protrusive lower lip
- Facial asymmetry: chin point deviated to right (Fig. 10)

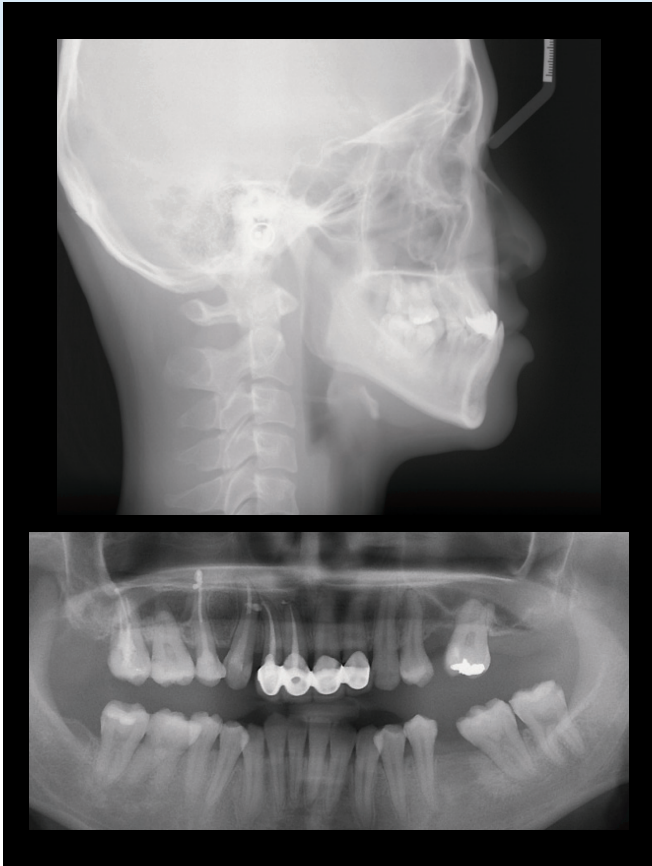
### Specific Objectives Of Treatment

#### Maxilla ( all three planes ):

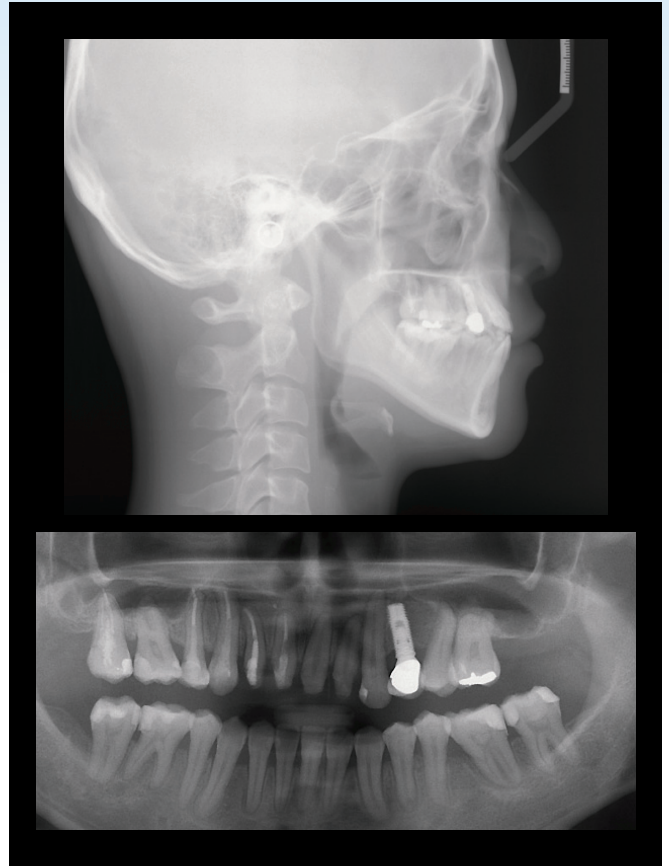
- A - P: Maintain
- Vertical: Maintain
- Transverse: Maintain

#### Mandible ( all three planes ):

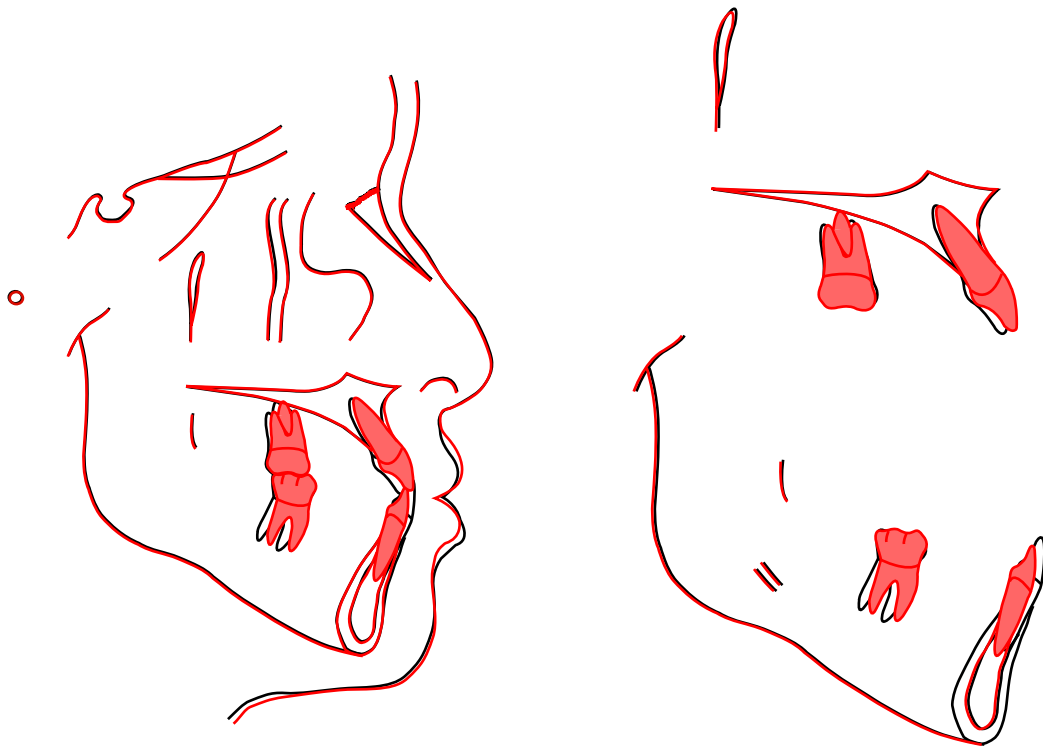
- A - P: Maintain



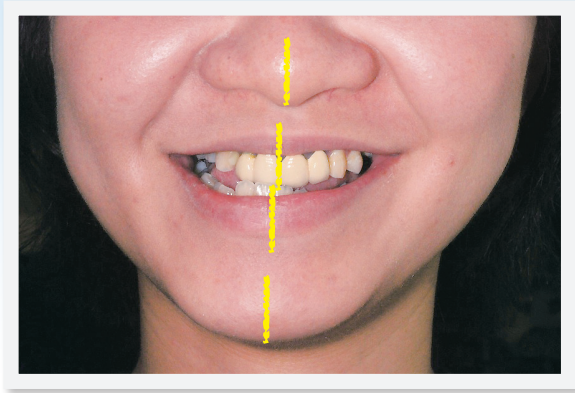
■ Fig. 7: Pretreatment pano and ceph radiographs



■ Fig. 8: Posttreatment pano and ceph radiographs



■ Fig. 9: Superimposed tracings revealed maxillary incisors tipping, mandibular incisors intrusion, and mandibular molar tipback .



■ Fig. 10:

Maxillary dental midline: a 3mm shift to the right of the facial midline. Mandibular dental midline: a 2mm shift to the right of the maxillary dental midline. Chin point deviated to the right of the facial midline.

- Vertical: Maintain
- Transverse: Maintain

#### Dentition :

- Correct Class III canine and molar relationship
- Correct anterior and posterior crossbite
- Create enough space for implantation of maxillary premolar
- Relieve mandibular crowding and close the remaining space
- Midline correction
- Remake prostheses for teeth #7, 8, 9, 10
- Implant-supported prosthesis to replace a maxillary premolar after orthodontic treatment

#### Facial Esthetics:

- Retract protrusive lower lip

The ABO Discrepancy Index (DI) was 39 as shown in the subsequent worksheet.<sup>1</sup>

### Treatment Plan

An orthognathic surgical approach was discussed for this asymmetric Class III malocclusion. However, the patient preferred a camouflage plan involving extraction of right lower 2<sup>nd</sup> premolar. Two options

were presented for restoring the maxillary left posterior segment: 1. an implant to replace #13, or 2. retraction of #12 for implant site development. Since the first option was more difficult and less predictable,

the orthodontics approach for implant site development was selected to produce a relatively flat bone area with sufficient height to receive an implant.

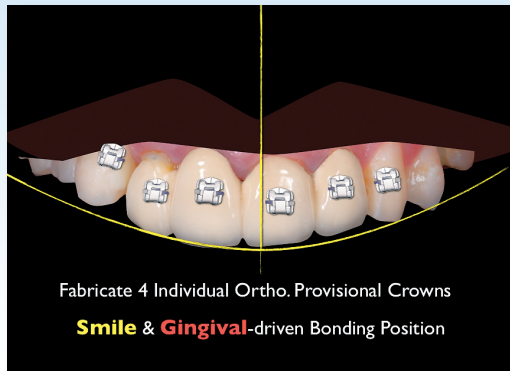
A full fixed orthodontic appliance was indicated to align and level the dentition. In the initial stage of treatment, an implant space was created between the left maxillary canine and first premolar. Mandibular anterior bite turbos assisted in overbite and overjet correction. Class III elastics were used to resolve the sagittal occlusal discrepancy, and detailing bends produced the final occlusion. The fixed appliances were removed and the corrected dentition was retained with fixed anterior retainers in both arches: Mx 2-2, Md 3-3.

### Appliances And Treatment Progress

After extracting the right mandibular 2<sup>nd</sup> premolar, both arches were bonded with .022"

Damon Q® brackets (*Ormco*). The low torque brackets to help prevent flaring were selected for the maxillary anterior provisional crowns (*Fig. 11*). Bite turbos were bonded on the mandibular central incisors to facilitate the correction of the anterior crossbite (*Fig. 12,13*). The patient was instructed to wear Class III elastics (*Parrot 5/16, 2 oz.*) full time.

In the 4<sup>th</sup> month of treatment, the NiTi open coil spring was placed between #11 and #12 (*Fig. 14*). The improvement in overjet from -2mm to 1mm



**Fig. 11:**  
After fabricating 4 individual ortho. provisional crowns, bond ant. braces following the smile & gingival margin position.



**Fig. 12:**  
Bond anterior bite turbos on the lower central incisors and apply light inter-arch elastics (2oz parrot, U6 to L3)

in 4 months was due to the combination of the anterior bite turbos, Class III elastics, and the patient's cooperation with treatment (Figs. 12-13). Both of the arch wires were changed to .014x.025 CuNiTi in the 7<sup>th</sup> month of treatment, and the position of the bite turbos was changed to the maxillary premolars.

In the 8<sup>th</sup> month, the mandibular arch wire was changed to .017x.025 TMA, and the bite turbos were removed. The crossbite elastics were applied, from the lingual buttons bonded on the maxillary 1<sup>st</sup> molars, to the tubes of mandibular molars. Power chains were placed on the mandibular arch to close the space.

After 10 months, the mandibular space was closed



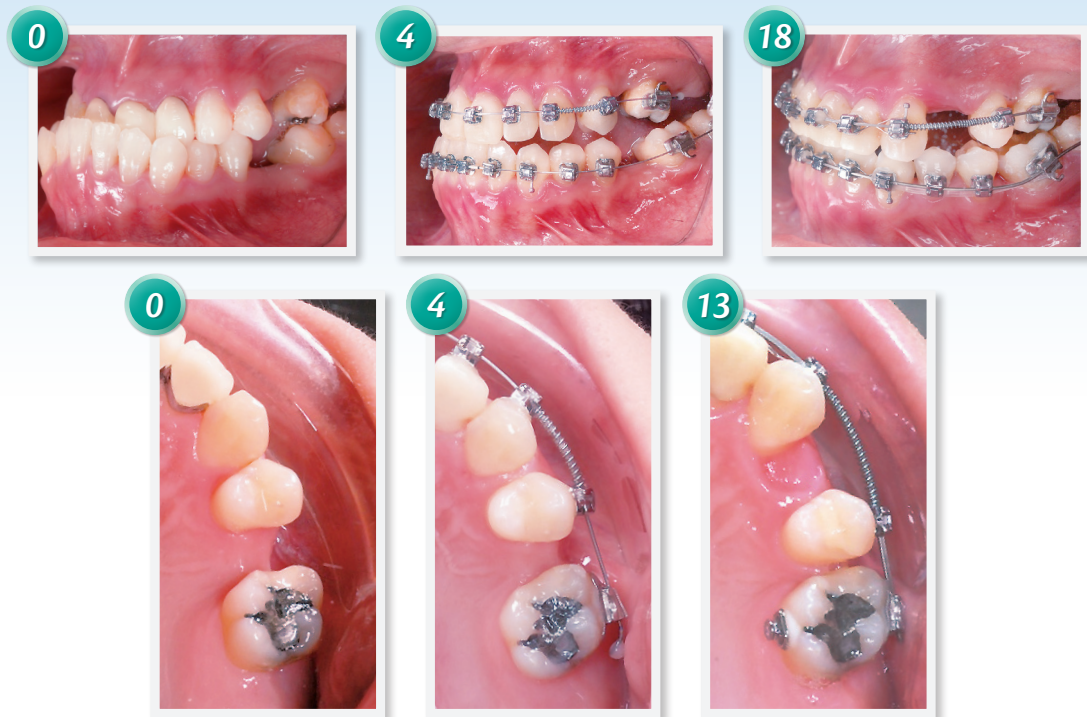
**Fig. 13,14:**  
After 4 months of the orthodontic treatment, the negative overjet reached an edge to edge position.

and #12 was in contact with #14 (Fig. 15). In the 18<sup>th</sup> month, a panoramic radiograph was taken to evaluate the space for implants (Fig. 16). The implant placement procedure was designed at this time.

### Implant Placement

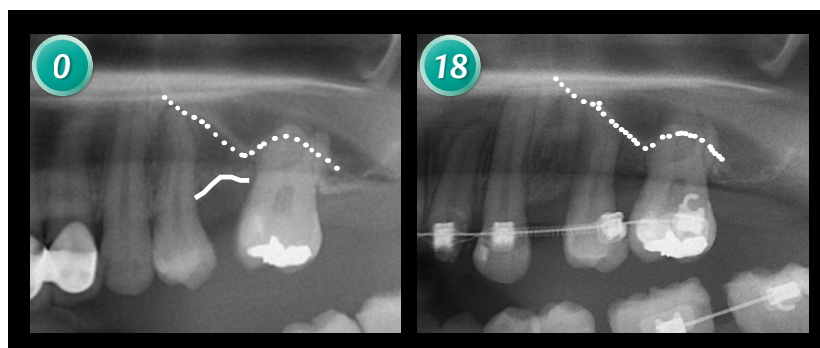
Before surgery, a three-dimensional cone beam computed tomography (CBCT) image was taken to evaluate bone density and volume: Height 13 mm and BL width 6mm was adequate for a 4x11.5 mm EZ Plus implant. The anatomic structure of the implant site is shown in Fig 17. A surgical stent was designed to guide the mesial-distal (M-D) and buccal-lingual (B-L) position. The implant fixture level was 3mm below the future crown margin), the angulation was less than 15° and the distance from adjacent teeth was at least 1.5mm (Figs. 18-19).<sup>2</sup>

A mid-crestal incision was executed with a number 15 scalpel blade, and sulcular incisions were performed with a number 12 scalpel blade on the buccal and palatal surfaces of the adjacent teeth. After exposing the bone with full thickness flaps,



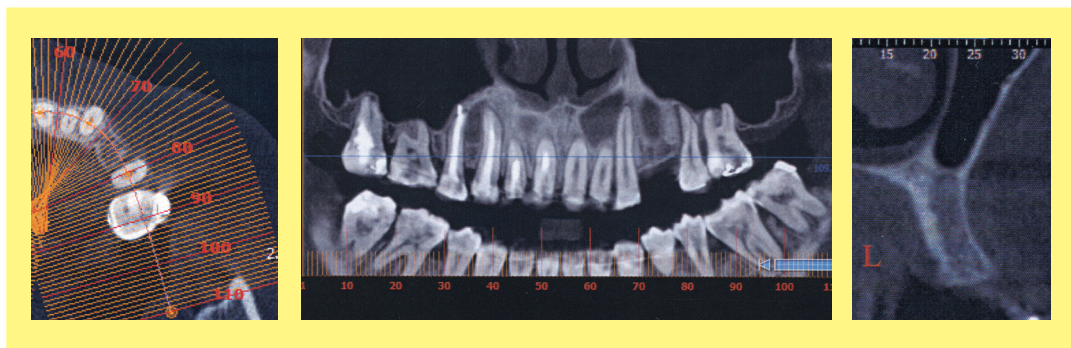
■ Fig. 15:

Retract #12 for implant site development with an open coil spring. The Atherton's patch was noticed over distal site of the #11 in the 13<sup>th</sup> month of the treatment.



■ Fig. 16:

Retract #12 for implant site development with open coil spring. The bone level of #12 space is more sufficient for implant fixture rather than #13 (sinus floor and tilted bone level).

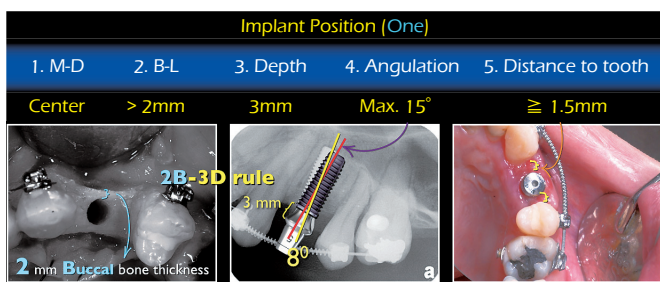


■ Fig. 17:

A three-dimensional cone beam computed tomography (CBCT) image was taken to evaluate bone density, volume (H: 13 mm BL: 6 mm, implant size: 4x11.5 mm EZ Plus), and the anatomic structure of the implant site.



■ Fig. 18:  
A surgical stent was designed to guide the implant position.

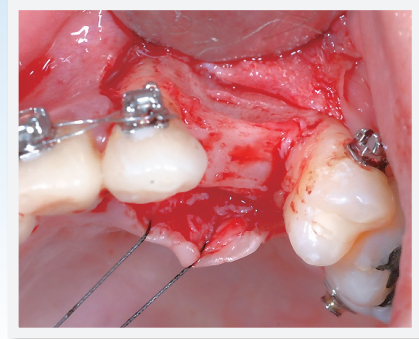


■ Fig. 19:  
A surgical stent was designed to guide mesial-distal (M-D) position, buccal-lingual (B-L) position, implant fixture level position (3 mm below the future crown margin), angulation (less than 15°) and distance from adjacent teeth (at least 1.5 mm).

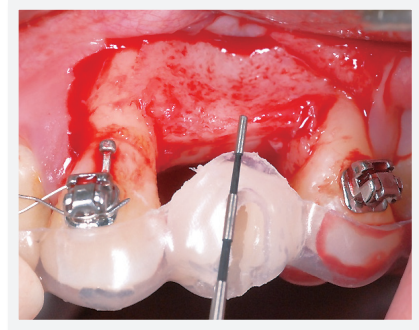
the buccal flap was sutured on the cheek and the palatal flap was pulled palatally with a needle holder to obtain a clear surgical view of the implant site (Fig. 20).

A surgical stent was used to guide the implant fixture to position 3mm below the planned crown margin (Fig. 21). After leveling the edentulous area with a bone scraper (Fig. 22), the width of the ridge was 6.5mm. A fixture with dimensions of 4.0x11.5mm was inserted into the ridge following the implant manufacturer’s recommended drilling and insertion protocol. Buccal bone thickness of 2mm was preserved after the osteotomy procedure (Figs. 23-25). The healing abutment was placed (Figs. 26-27).

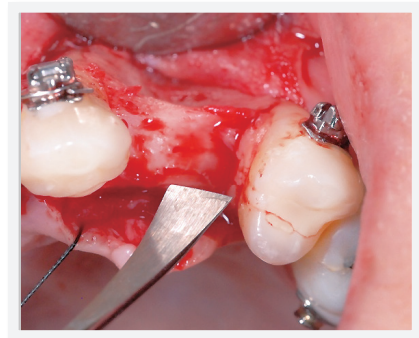
A bony concavity was noticed after the fixture insertion, but there was no fenestration of the implant (Fig. 26). A free gingival graft was harvested



■ Fig. 20:  
The buccal flap was sutured on the cheek and the palatal flap was pulled palatally with a needle holder.



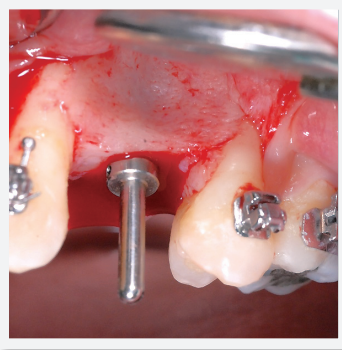
■ Fig. 21:  
Surgical stent was used as a guide for implant fixture level position (3mm below future crown margin).



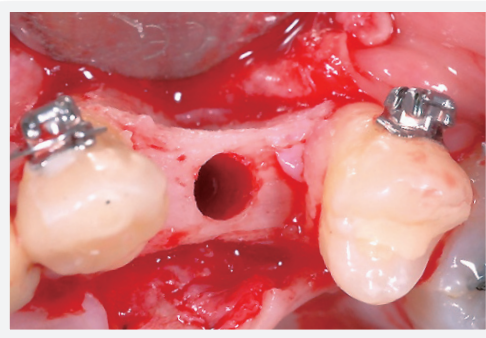
■ Fig. 22: leveling the edentulous area with bone scraper.



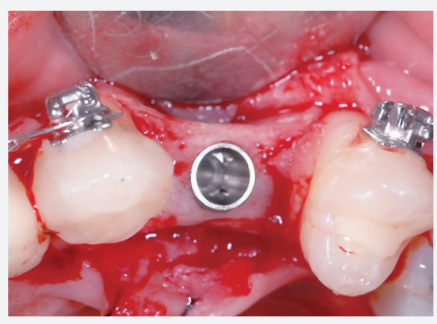
■ Fig. 23: Osteotomy procedure started from first lance drill.



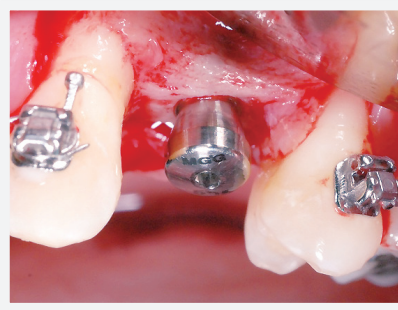
■ Fig. 24: Use guide pin to check the axis.



■ Fig. 25: Preserve 2mm thickness of the buccal bone after osteotomy procedure.

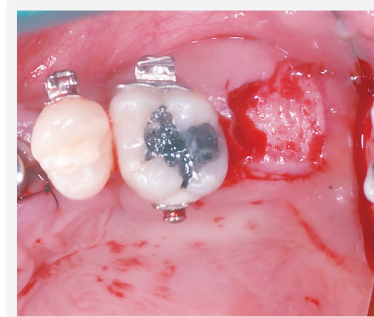


■ Fig. 26: EZ plus implant fixture 4x11.5 mm was inserted into prepared site.

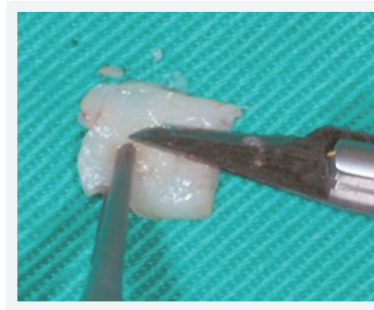
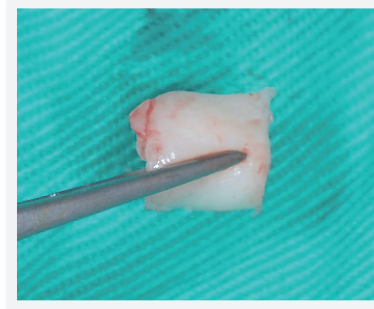


■ Fig. 27: Connect with healing abutment. Bony concavity was noted and there was no fenestration over apical area of the implant.

from the tuberosity area (Fig. 28a,b) and the epithelium layer was removed with a number 15c scalpel blade (Fig. 29). The resulting connective tissue graft was then positioned under the buccal flap, and retained with catgut sutures (Fig. 30). The flap was repositioned and sutured with interrupted 5-0 nylon sutures. Note the catgut suture securing the connective tissue graft (Fig. 31). After 1 week, the sutures were removed and a follow-up periapical film was taken (Fig. 32a,b,c). The prosthesis was planned for delivery following a 6 month healing interval.

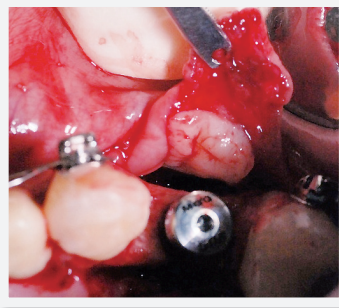


■ Fig. 28a,b: Harvest free gingival graft from tuberosity.

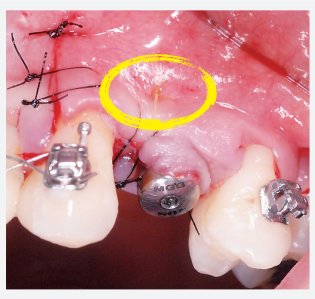


■ Fig. 29: Remove epithelium layer with No.15c scalpel.





**Fig. 30:**  
Tuberosity graft was fixed beneath the buccal flap with catgut suture.



**Fig. 31:**  
The flap was sutured with interrupted 5-0 nylon sutures, and the catgut suture was shown.



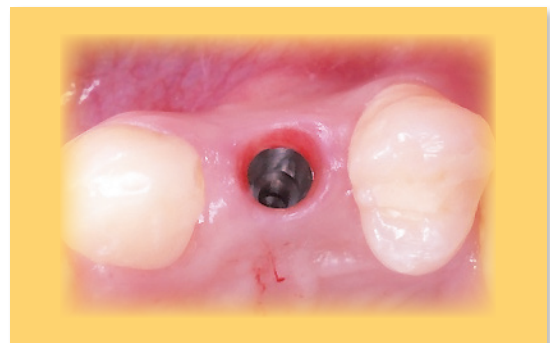
**Fig. 32a,b,c:**  
After 1 week, suture were removed. Check periapical film.

### Orthodontic Finishing Stage

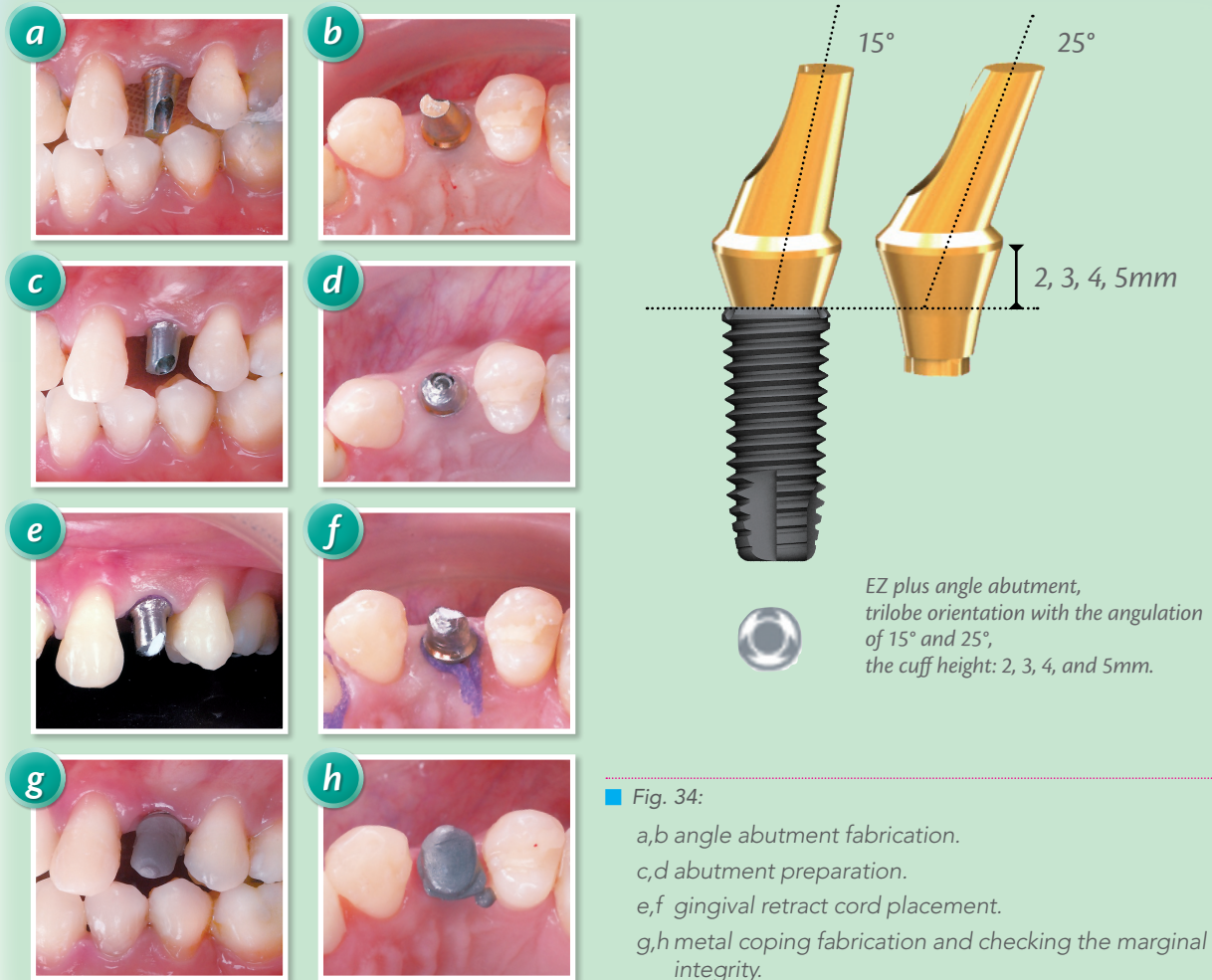
A panoramic radiograph was taken to evaluate bracket positions relative to the axial inclinations of all teeth. Two weeks prior to the completion of active treatment, the upper archwire was sectioned distal to cuspids. Light up-and-down elastics (2 oz) were used posteriorly for final detailing of the buccal segments. The wire sequence was: .014 NiTi, .014x25 NiTi, .017x25 TMA, and .19x25 SS. After 31 months of active treatment, all appliances were removed. Upper clear overlay and fixed anterior (Mx 2-2, Md 3-3) retainers were delivered for both arches.

### Prosthesis Fabrication

In the 31<sup>th</sup> month of orthodontic treatment (including 13 months of implant healing), the brackets were debonded and referred for restorative management. The healing abutment was removed (Fig. 33) and replaced with an angled abutment (Fig. 34a,b). After abutment preparation (Fig. 33c,d), the gingival retraction cord was positioned in the gingival sulcus with packing-placement instruments (Fig. 34e,f). A direct impression, made with polyvinyl siloxane, was poured with type IV dental stone, and the casts were subsequently articulated using the appropriate



**Fig. 33:**  
In the 31<sup>th</sup> months of orthodontic treatment (including 13 months of implant healing period), Orthodontic treatment was finished and implant prosthesis procedure had been arranged. Healing abutment was removed and intact sulcus was noticed.

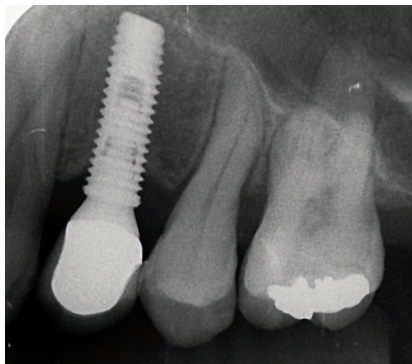


■ Fig. 34:  
 a,b angle abutment fabrication.  
 c,d abutment preparation.  
 e,f gingival retract cord placement.  
 g,h metal coping fabrication and checking the marginal integrity.



■ Fig. 35:  
 Appropriate tightness of the contact area was confirmed with dental floss. The occlusal area was made of porcelain for esthetic concern.

check-bite records. A metal coping was fabricated by the laboratory, and the marginal integrity was verified with a dental explorer (Fig. 34g,h). After completion of the final prosthesis, appropriate tightness of the contact area was confirmed with dental floss. The occlusal area was made of porcelain because of the patient's esthetic concerns. After clinical adjustment and verification of the fit and occlusion, the definitive crown was completed and luted into place with temporary cement (Figs. 35-36).



■ Fig. 36: Take peri-apical film was taken for checking margin integrity.

The crown remover on the lingual side was trimmed off a week later.

## Results Achieved

### Maxilla (all three planes):

- A - P: Maintained
- Vertical: Maintained
- Transverse: Maintained Mandible (all three planes):
- A - P: Maintained
- Vertical: Maintained
- Transverse: Maintained Maxillary Dentition
- A - P: Slightly flared incisors ~ 3degrees
- Vertical: Maintained
- Inter-molar / Inter-canine Width: Maintained

### Mandibular Dentition

- A - P: Incisors retracted
- Vertical: Molar uprighted
- Inter-molar / Inter-canine Width: Maintained

Facial Esthetics: Lower lip retruded

## Retention

The fixed retainer was bonded on all maxillary incisors and from canine to canine in the mandibular arch. An upper clear overlay was delivered with instructions to wear it full time for the first 6 months and nights only thereafter. The patient was also instructed in the home care and maintenance of the retainers.

## Final Evaluation Of Treatment

The ABO Cast-Radiograph Evaluation score was 19 points. The major discrepancies were alignment/rotation, marginal ridges, and root angulation (Fig. 37).<sup>1</sup> The anterior crossbite, contributing to the

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	86°	87°	1°
SNB°	87°	86.5°	0.5°
ANB°	-1°	0.5°	1.5°
SN-MP°	38°	38°	0°
FMA°	31°	31°	0°
DENTAL ANALYSIS			
U1 TO NA mm	5 mm	8 mm	3 mm
U1 TO SN°	115°	118°	3°
L1 TO NB mm	8 mm	7 mm	1 mm
L1 TO MP°	82°	81°	1°
FACIAL ANALYSIS			
E-LINE UL	-2 mm	-1 mm	1 mm
E-LINE LL	2 mm	0.5 mm	1.5 mm

■ Table. 1: Cephalometric summary



■ Fig. 37: The major discrepancies were alignment/rotation, marginal ridges, and root angulation.

Class III relationship was corrected. The orthodontic movement of #12 before the implantation simplified the surgical procedure. Overall, this complex case was treated to an acceptable dental result by combined orthodontic and implant-prosthetic treatment.

## Discussion

The classical belief holds that a force acting on a tooth generates bone resorption on the pressure side of the periodontal ligament (PDL) and apposition on the tension side, but that a tooth can only be moved within existing bone. But clinical experience has shown that it's possible to move teeth through many anatomic limitations such as the sinus floor, sutures, or cortical bone barriers.<sup>3</sup> The concept that teeth can be moved "with the bone" is really movement of a tooth "through the bone" because new bone forms ahead of it. "Force level" and especially the "moment to force ratio" determines the distribution of orthodontic forces within the periodontal structures. When a therapeutic force is initially applied, hyalinization occurs in the PDL, necessitating (*undermining*) resorption before substantial movement occurs. On the other hand, the tooth will rapidly form new bone

in areas of PDL tension, by an extensive proliferative response to make new osteoblasts.<sup>4</sup> Radiographic evaluation of orthodontic tooth movement revealed that 6 months of active treatment resulted in bodily movement through the floor of the maxillary sinus. The tooth retained its alveolar bone support by inducing new bone in the path of tooth movement. There was no loss of connective tissue or gingival attachment. The space opened in the maxillary premolar area allowed for the insertion of an implant to support a prosthetic crown. The result of the present clinical case suggest that a tooth with a healthy periodontium can be orthodontically moved through the maxillary sinus while maintaining pulp vitality, bone support and exhibiting a normal width of the periodontal ligament both on the pressure and tension sides.<sup>5</sup> An adequate implant site was generated orthodontically, so a sinus lift surgical augmentation procedure was not necessary.<sup>6</sup>

When a tooth is moved, changes may be observed in the surrounding gingiva. Movement of a tooth may result in an opening (*eversion*) of the gingival sulcus on the trailing tooth surface, producing a red patch, and also epithelial creases in the path of tooth movement.<sup>7</sup>

Evaluating the success of an implantation procedure requires an assessment of gingival esthetic changes after surgical healing and prosthesis delivery (*the IBOI Pink & White Esthetic Score*).<sup>8</sup> Implant position and abutment selection are also major concerns for the esthetic result. Two items have been added to the IBOI esthetic score. Assessing the IBOI Implant-Abutment Transition & Position Analysis requires assessment of: 1. Implant position, and 2. implant-abutment transitional contour (Fig. 38).<sup>9</sup>



**Fig. 38:** IBOI esthetic score system for implant/ restorations evaluation, including: pink esthetic, white esthetic, implant position and transitional contour.

### 1. Pink esthetic score

The gingival response is assessed by the Pink Esthetic Score (PES),<sup>10</sup> from clinical photographs. Six variables are scored from 0→2: mesial & distal papillae, keratinized gingiva, curvature of the gingival margin, level of the gingival margin, root convexity (*torque*), and scar formation.

Mesial and distal papillae are assessed for a complete papilla (*score 0*), incomplete papilla, (*score 1*), or absence of a papilla (*score 2*). The keratinized gingiva is scored as thick biotype (*score 0*), thin biotype (*score 1*) or absence of keratinized gingiva (*score 2*). The curvature of the gingival margin, also defined as the line of emergence of the gingival margin, is evaluated as being identical to comparative teeth (*score 0*), slightly different (*score 1*), or markedly different (*score 2*). The level of the gingival margin is scored by comparison to the contralateral tooth in terms of an identical vertical level (*score 0*), a slight ( $\leq 1mm$ ) discrepancy (*score 1*), or a major ( $\geq 1mm$ ) discrepancy (*score 2*). The root convexity (*labial eminence*) combines three additional specific soft tissue parameters as one variable: presence (*score 2*), partial presence (*score 1*), or absence (*score 0*) of a convex profile in the facial aspect. The scar formation is scored by the absence of scar (*score 0*), moderate scar formation (*score 1*), and severe scar formation (*score 2*).

### 2. White esthetic score

The white esthetic score (WES) for the anterior segment is assessed from clinical photographs. Six variables are scored from 0→2: midline, incisor curve, axial inclination, contact area, tooth proportion, and tooth to tooth proportion. For a single crown, there are also 6 variables: tooth form, mesial & distal outline, crown margin, translucency, hue & value, and tooth proportion.

#### For micro-esthetic score:

The midline is evaluated as follows: upper midline equal to lower midline (*score 0*), midline off <3mm (*score 1*), or midline  $\geq 3mm$  (*score 2*). The incisor curve is scored as a smooth curve (*score 0*), uneven

curve (*score 1*) or missing curve with or without crowding (*score 2*). The axial inclination, aligned with standard angulation 5°, 8°, 10°: (*score 0*), slightly different: (*score 1*), or crowding/spacing: (*score 2*). The contact area is assessed as the ratio of the contact area to crown length from central incisor to canine: ideal proportion 50% : 40% : 30% (*score 0*), asymmetrical contact areas on mesial and distal (*score 1*), or elongation of the contact area (*score 2*). Tooth proportion is scored as follows: 1: 0.8 (*score 0*), slightly too long (*score 1*), excessively long (*score 2*). Tooth to tooth proportion should follow the golden proportion ( 1.6:1:0.6 ): (*score 0*), a slight discrepancy (*score 1*), missing/ crowding teeth (*score 2*).

#### White esthetic score for a single restoration:

A score of 2, 1, or 0 is assigned for all six parameters. Thus, in the case of an optimum implant/tooth restoration, a score of 0 is recorded. All six parameters are assessed by direct comparison with a natural contralateral reference tooth, by estimating the degree of match or eventual mismatch. In the case of an optimum duplication of the esthetically relevant features, relative to the control tooth, a score of 0 is assigned.

For the Pink Esthetic Score, the insufficient soft tissue contour and loss of the papillae are scored. The supra-gingival porcelain margin and narrow outline of the crown are evaluated on the WES. This score is optimized by an ideal implant position and abutment selection.

### 3. Implant position

There are 5 keys<sup>11</sup> for placing the implant during the surgical procedure: mesial-distal (M-D) position, buccolingual (B-L) position, depth, angulation,

and distance to adjacent anatomical structures. A detailed description of each key follows:

- A. M-D position: The hole to receive the implant should align with the center of the restored crown (*score 0*), shift to one side (*score 1*), and close to or touching an adjacent tooth (*score 2*). A surgical stent may be used as the guide.
- B. B-L position: It is important to preserve 2mm of buccal bone thickness after implant placement (*score 0*). If the buccal bone plate is less than 2mm, the options are: (a) place the implant more lingually, (b) choose a smaller diameter implant fixture, and/or (c) augment buccal bone with a guided bone regeneration (GBR) procedure to improve buccal bone thickness. If the buccal bone plate is less than 2mm (*score 1*), and if there is no buccal bone plate (*score 2*).

For the present patient, the 2mm buccal bone plate was preserved. Viewing the CBCT slices, the concavity of the middle portion of the bone ridge was noted. After implant insertion, a CT graft was harvested from the tuberosity area, and sutured beneath the buccal flap, to augment the soft tissue thickness. In retrospect, a larger CT graft and/or combination with particulate bone graft would have provided a more harmonious soft tissue profile (Fig. 39).

- C. Depth: The implant fixture should be placed 3mm below the future crown margin (*score 0*). If less than 3mm (*score 1*), and if deeper than 3mm (*score 2*).<sup>12</sup>
- D. Angulation, the implant axis should be parallel with the adjacent teeth (*score 0*). It's important to place the guide pin and take a peri-apical X-ray

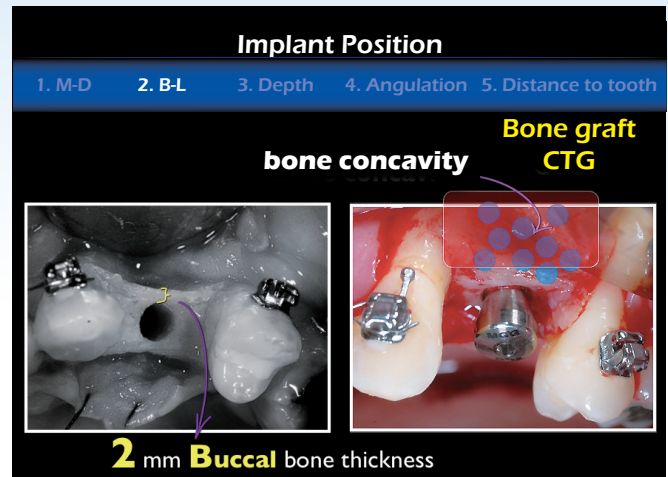
film to check the axis before implant insertion. Especially when orthodontics is used to open a space, the patient should be referred for an X-ray to check the root position of the adjacent teeth. If an adjacent root is too close, it's difficult for the surgeon to insert the implant without damaging it. If the tilted angulation is less than 15 degrees (*score 1*), or more than 15 degrees (*score 2*). In the present case, the axis of the implant fixture was aligned with the canine during the surgical stage. But the panoramic film showed that the axis was distally tilted ~8 degrees. That was the reason the angled abutment was used for axis correction. When opening a space with orthodontics, special care must be taken to apply an adequate moment to control the root position. An x-ray of the guided pin should be taken before implant fixture insertion (Fig. 40).

E. Distance to adjacent anatomical structures: For a single implant, the fixture should be at least 1.5mm away from adjacent teeth to preserve the proximal bone level (*score 0*). If less than 1.5mm *score 1*, or if touching an adjacent tooth or other important anatomical structure *score 2*.

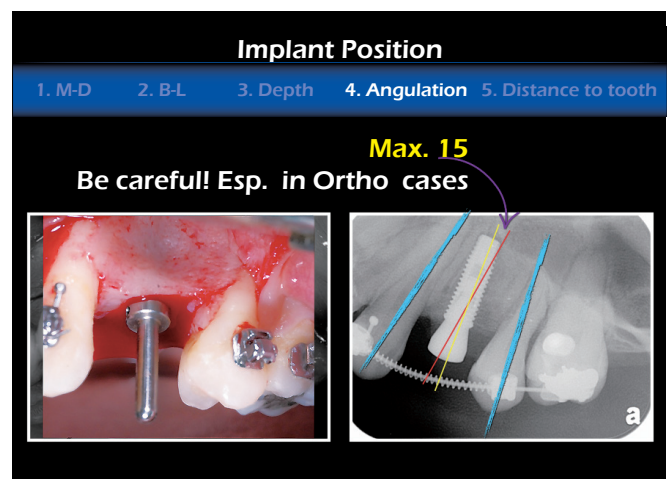
#### 4. Implant-abutment transitional contour

There are nine factors which affect final esthetic result: fixture cervical design, platform switching, implant-abutment (I-A) connection type, abutment selection, screw hole position, marginal bone loss, sulcus height, modified gingival contour, and crown margin fit. The last four items are assigned a score.

Fixture cervical design: For esthetic reasons, a bone level implant should be selected, which does not



■ Fig. 39: In this case, we preserved the 2mm buccal bone plate. From the slice view of the CBCT, the concavity of middle portion of the bone ridge was noticed. After implant insertion, we harvested CT graft from the tuberosity area and sutured beneath the buccal flap for augmentation of the soft tissue thickness. If we treat this kind of case again, larger CT graft and/or combination with particle bone graft on this area may provide more harmonious soft tissue profile.



■ Fig. 40: In our case, the axis of the implant fixture was aligned with the canine during surgical stage. But the panorex film showed the axis was too distally tilted by 8 degrees. That was the reason we used the angle abutment for axis correction. For this kind of case, after opening a space special care must be taken with orthodontic torque control for root axis. An x-ray of guided pin should be taken before implant fixture insertion.

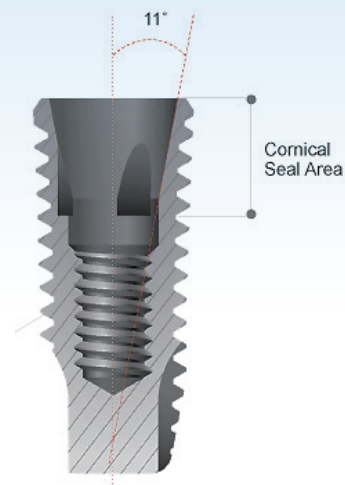
have a smooth collar on the cervical portion of the fixture.

Platform switching and I-A connection type (*E: external connection, I: internal connection*): For example: EZ Plus implant has platform switching design, which maintains crestal bone. In addition, an 11° morse taper produces a conical seal which forms a cold weld between the abutment and the implant (Fig. 41). The platform switching and morse taper design prevent microgap movement, and promotes a beautifully keratinized soft tissue response.

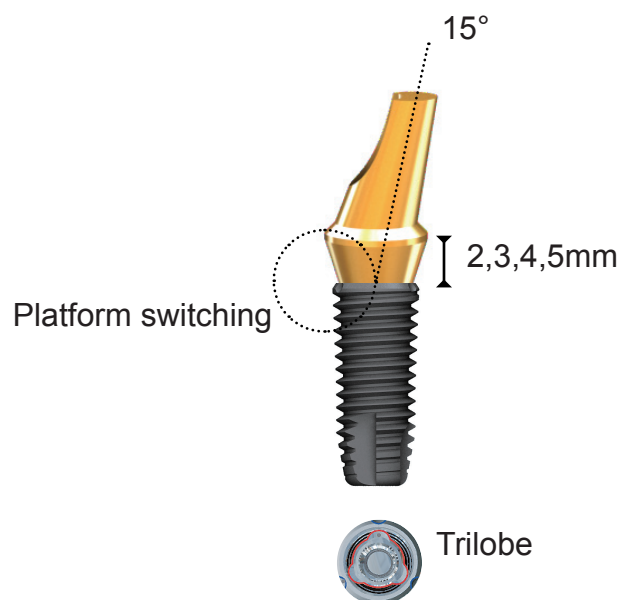
Abutment selection (*S: screw-retained, C: cement-retained*): For a cement-retained abutment, there are many choices for different situations: one-piece, two-piece, custom milling, or a UCLA customized abutment. For the present patient, an angled abutment (15° with cuff height of 4mm) was selected to compensate for the long axis of the implant (Fig. 42). After abutment fabrication, the preparation procedure was carried out intra-orally.

Screw hole position (*B: buccal, L: lingual*): In this case, the screw hole to retain the crown was visible on the labial surface of abutment. The screw-retained prosthesis will be esthetically compromised when the patient smiles due to an obvious screw hole.

Marginal bone loss: If there is no bone loss at the time of crown delivery, the score is 0. According to ICOI Consensus conference meeting in 2007 (Fig. 43), the criteria for a successful implant is defined as: a. no pain or tenderness upon function, b. no mobility, c. <2mm radiographic bone loss from the initial surgery, and d. no history of exudation. If < 2mm bone loss at the time of crown delivery score 1, and



■ Fig. 41: EZ Plus implant has platform switching design, which maintains crestal bone, and in addition, it incorporates an 11° morse taper, producing a conical seal which forms a cold weld between the abutment and the implant.



■ Fig. 42: Angle abutment (15° with cuff height 2,3,4, or 5 mm) for axis compensation. The platform switching and morse taper design prevent microgap movement and allow for a beautifully keratinized tissue response.



Implant Quality Scale Group	Clinical Concitions
I. Success ( <i>optimum health</i> )	<ul style="list-style-type: none"> <li>a) No pain or tenderness upon function</li> <li>b) 0 mobility</li> <li>c) &lt; 2mm radiographic bone loss from initial surgery</li> <li>d) No exudates history</li> </ul>
II. Satisfactory survival	<ul style="list-style-type: none"> <li>a) No pain on function</li> <li>b) 0 mobility</li> <li>c) 2-4mm radiographic bone loss</li> <li>d) No exudates history</li> </ul>
III. Compromised survival	<ul style="list-style-type: none"> <li>a) May have sensitivity on function</li> <li>b) No mobility</li> <li>c) Radiographic bone loss &gt; 4mm (<i>less than 1/2 of implant body</i>)</li> <li>d) Probing depth &gt; 7mm</li> <li>e) May have exudates history</li> </ul>
IV. Failure ( <i>clinical or absolute failure</i> )	<p>Any of following:</p> <ul style="list-style-type: none"> <li>a) Pain on function</li> <li>b) Mobility</li> <li>c) Radiographic bone loss &gt; 1/2 length of implant</li> <li>d) Uncontrolled exudate</li> <li>e) No longer in mouth</li> </ul>

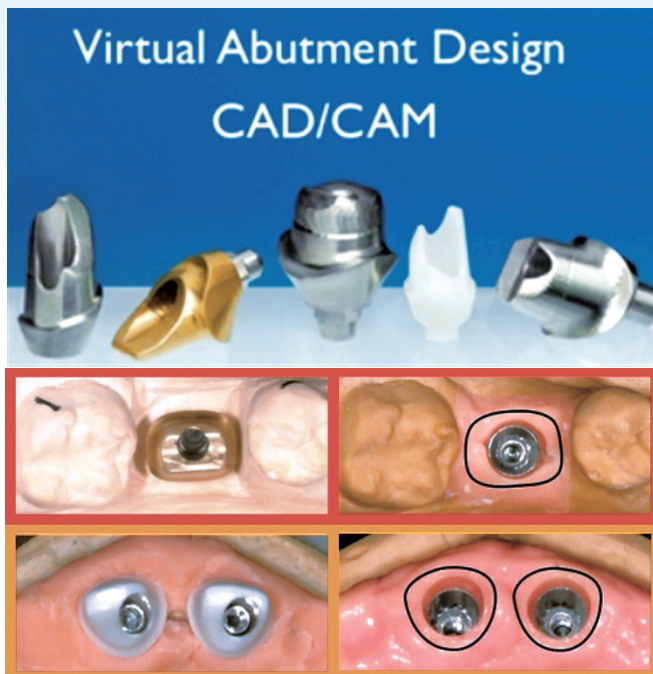
■ Fig. 43. ICOI, Consensus conference meeting, 2007: Criteria for implant success

if more than 2mm bone loss score 2. For the present patient, the marginal bone loss was about 1.8mm after abutment connection. The follow-up protocol is necessary for evaluation of the implant success rate long-term.

Sulcus height: The ideal sulcus depth around an implant is about 3mm for the biologic width (*score 0*). If less than 3mm score 1, and if more than 3mm score 2. For the present patient, the sulcus depth around the implant was about 3mm, and the crown margin was equal to the gingival margin. A dark shallow was noted in the gingival margin area. In retrospect, locating the crown margin 1mm subgingivally, or using the Zirconium (Zr) customized abutment may have solved the problem.

Modified gingival contour: If papillae are insufficient and cause a dark triangle, the CAD/CAM customized abutment can be useful to the move the crown emergence closer to the natural teeth to achieve the best interproximal contact. This design will help regain the interdental papilla. If the implant crown interproximal contact, measured to the crestal bone of adjacent teeth, is less than 5mm the papilla will be restored 95% of the time. To assess papillae height, measure the modified gingival contour: 100% papillae fill (*score 0*), papillae less than 100% fill (*score 1*), and no papillae (*score 2*) (Fig. 44).

Crown margin fit: on the periapical film, check the integrity of crown margin to the abutment. If it is 100% fit (*score 0*), small gap (*score 1*), or the crown doesn't fit in the abutment (*score 2*).



■ Fig. 44:

The CAD/CAM customized abutment can be useful to move the crown emergence closer to the natural teeth to achieve the best interproximal contact. This design will ensure us to regain the interdental papilla. The papilla will be restored 95% of the time if the implant crown interproximal contact measured to the crestal bone of adjacent teeth is less than 5mm.

## Conclusion

When treating a Class III malocclusion, combined with a multiple missing teeth, a treatment plan considering the orthodontic, surgical and prosthodontic aspects is necessary. When the bone height is poor, implant site preparation is needed. Orthodontic tooth movement can facilitate the bone quantity without additional surgical augmentation.

When evaluating the implantation, the Pink and White esthetic Scores are important. Adjustments of implant position and abutment connection can improve the result.

## Acknowledgment

Thanks to Ms. Tzu Han Huang for proofreading this article.

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# Discrepancy Index Worksheet

**TOTAL D.I. SCORE** 39

**OVERJET**

- 0 mm. (edge-to-edge) = 1 pt.
- 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 = 18

**OVERBITE**

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

Total = 3

**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 = 1

**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.  
                                    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 ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° \_\_\_\_\_x 1 pt. = \_\_\_\_\_

Each degree > 6° \_\_\_\_\_x 1 pt. = \_\_\_\_\_

**SN-MP**

≥ 38°                      **38°**                  = 2 pts.

Each degree > 38° \_\_\_\_\_x 2 pts. = \_\_\_\_\_

≤ 26°                      = 1 pt.

Each degree < 26° \_\_\_\_\_x 1 pt. = \_\_\_\_\_

l to MP ≥ 99° = 1 pt.

Each degree > 99° \_\_\_\_\_x 1 pt. = \_\_\_\_\_

Total = 2

**OTHER**      (See Instructions)

Supernumerary teeth \_\_\_\_\_x 1 pt. = \_\_\_\_\_

Ankylosis of perm. teeth \_\_\_\_\_x 2 pts. = \_\_\_\_\_

Anomalous morphology \_\_\_\_\_x 2 pts. = \_\_\_\_\_

Impaction (except 3<sup>rd</sup> molars) \_\_\_\_\_x 2 pts. = \_\_\_\_\_

Midline discrepancy (≥3mm) @ 2 pts. = 2

Missing teeth (except 3<sup>rd</sup> molars) **4** x 1 pts. = 4

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. = 3

Addl. treatment complexities \_\_\_\_\_x 2 pts. = \_\_\_\_\_

Identify:

Total = 9

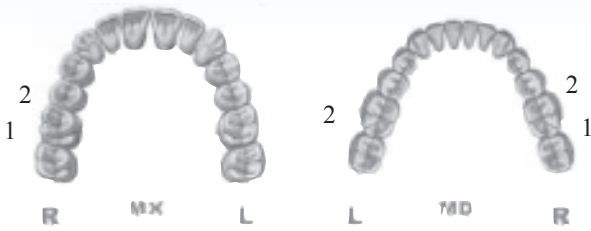
# Cast-Radiograph Evaluation

Case # 1 Patient

Total Score: **19**

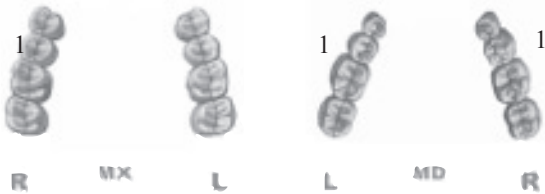
## Alignment/Rotations

8



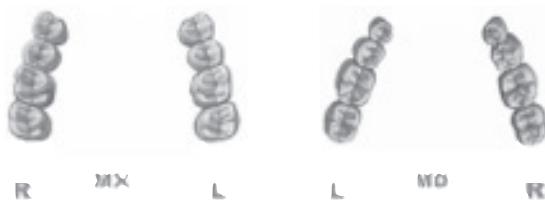
## Marginal Ridges

3



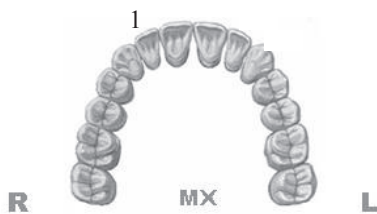
## Buccolingual Inclination

0



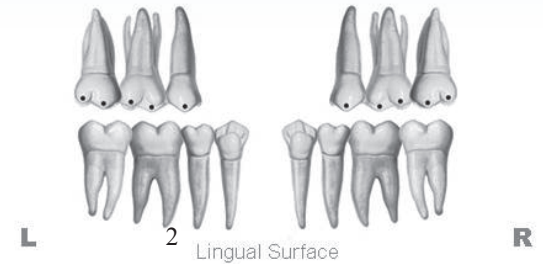
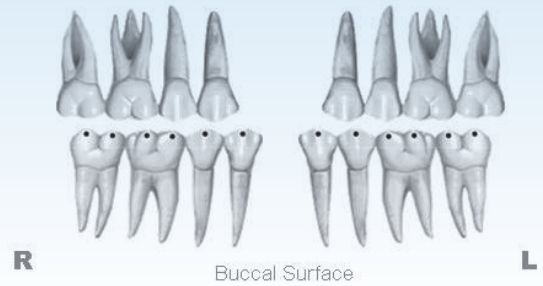
## Overjet

1



## Occlusal Contacts

2



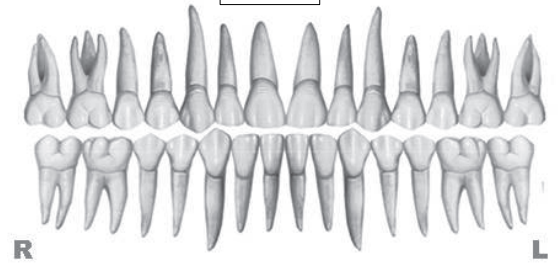
## Occlusal Relationships

0



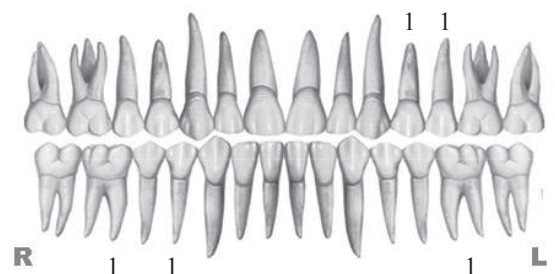
## Interproximal Contacts

0



## Root Angulation

5

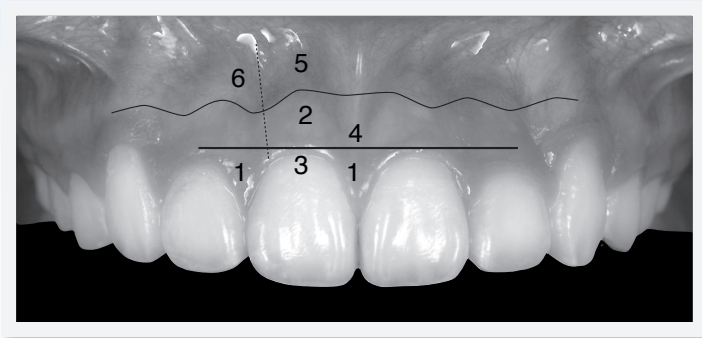


**INSTRUCTIONS:** Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

## IBOI Pink & White Esthetic Score

Total Score: = 12

### 1. Pink Esthetic Score

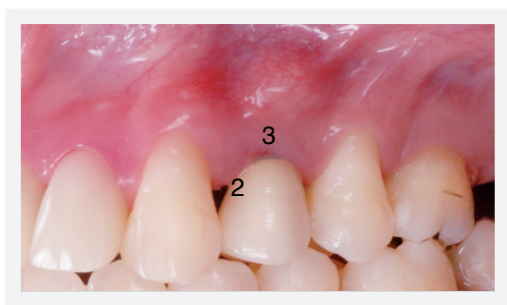
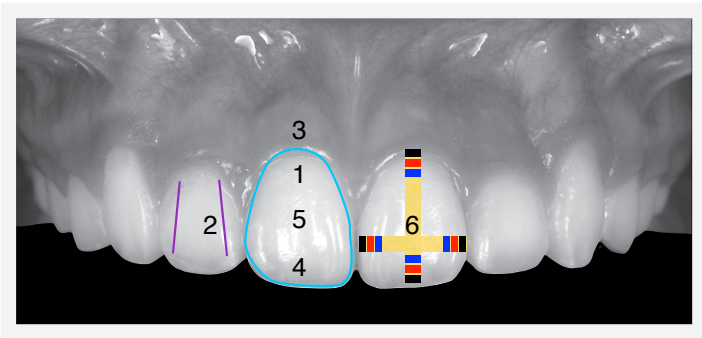


Total = 3

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 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

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



Total = 3

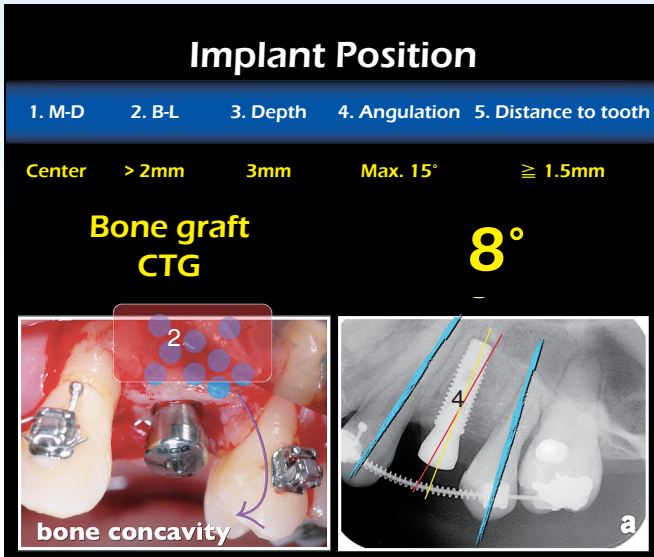
1. Tooth Form	0	1	2
2. Mesial & Distal Outline	0	1	2
3. Crown Margin	0	1	2
4. Translucency ( Incisal third )	0	1	2
5. Hue & Value ( Middle third )	0	1	2
6. Tooth Proportion	0	1	2

1. Tooth Form	0	1	2
2. Mesial & Distal Outline	0	1	2
3. Crown Margin	0	1	2
4. Translucency ( Incisal third )	0	1	2
5. Hue & Value ( Middle third )	0	1	2
6. Tooth Proportion	0	1	2

## IBOI Implant-Abutment Transition & Position Analysis

### 3. Implant Position

Total = 2

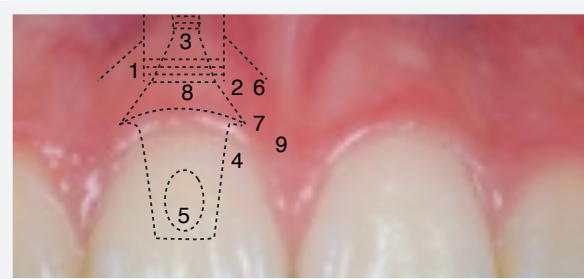


1. M & D ( Center )	0	1	2
2. B & L ( Buccal 2 mm )	0	1	2
3. Depth ( 3 mm )	0	1	2
4. Angulation ( Max. 15° )	0	1	2
5. Distance to Adjacent Anatomy	0	1	2

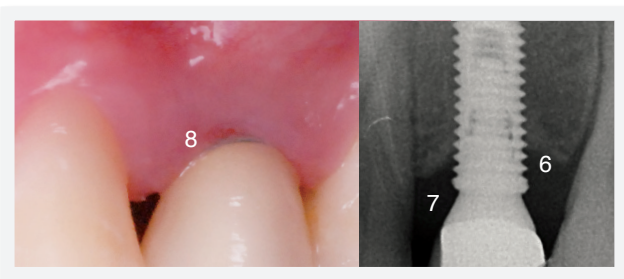
1. M & D ( Center )	0	1	2
2. B & L ( Buccal 2 mm )	0	1	2
3. Depth ( 3 mm )	0	1	2
4. Angulation ( Max. 15° )	0	1	2
5. Distance to Adjacent Anatomy	0	1	2

Total = 4

### 4. Abutment transition Contour



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



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. Soft Tissue Height	N	Y	0	1 2
8. Modified Gingival Contour	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. Soft Tissue Height	N	Y	0	1 2
8. Modified Gingival Contour	N	Y	0	1 2
9. Crown Margin fitness	N	Y	0	1 2