Mutilated Class II Division 2 Malocclusion: Implant-Orthodontic Treatment Utilizing Flapless Implant Surgery and Platelet-Rich Fibrin

SUMMARY

This severe mutilated Class II malocclusion (DI=36) in a adult female was managed with combined orthodontics and implant-supported prostheses. The upper right 1st molar and hopeless lower right 2nd molar were extracted, and the adjacent 2nd or 3rd molars were moved mesially to close the space. The missing left upper 1st molar was restored with a flapless implant procedure, to preserve available bone and soft tissue. Although there was a modest compromise in the buccal interdigitation, this interdisciplinary approach resulted in an excellent, cost effective improvement in occlusal function (CRE+20) and dental esthetics (P&I=3). (Int l Ortho Implantol 2014;33:22-47)

Key word:

Deep bite, atypical extractions, implant-supported prosthesis, flapless implant surgery, platelet-rich fibrin (PRF)

History and Etiology

A 20-year-old female patient was referred by her general dentist for an orthodontic consultation to evaluate the patient's chief concern: unattractive smile (*Figs. 1-3*). This problem was resolved to the patient's satisfaction with implant-orthodontic treatment (*Figs. 4-6*). Despite a broad array of dental problems that will be specified, there was no contributing medical history. Pretreatment photographs showed a relatively straight profile with irregular anterior gingival margins and an inadequate display of dental proportions when smiling. The maxillary and mandibular midlines were shifted to the left, which may be related to three missing teeth: maxillary left 2nd premolar, maxillary left 1st molar, and mandibular left 1st premolar. The intraoral photographs (*Fig. 2*) revealed the residual roots of a hopeless mandibular right 2nd molar, and a maxillary right 1st molar with a poor prognosis due to extensive loss of tooth structure. The panoramic radiograph (*Fig. 7*) revealed a horizontally impacted mandibular left 3rd molar, and three endodontically treated teeth: the maxillary right 1st molar and both upper central incisors. Because of a lack of patient availability, the total dental treatment time was 5 years and 9 months for two phases of fixed appliance treatment, that was followed by an implant-supported crown to restore the left maxillary 1st molar in the site of the adjacent 2nd premolar. There was a one year pause in the orthodontics treatment because the patient was overseas on business. Post-treatment lateral cephalometric and panoramic radiographs illustrate the dental alignment achieved (*Fig. 8*), and superimposed cephalometric tracings (*Fig. 9*) document the dental and facial results.

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Fig. 1. Pre-treatment facial photographs

Fig. 2:

Pre-treatment intraoral photographs reveal a deep overbite situation, upper right 1st molar with poor prognosis , lower right 2nd molar residual roots, and three missing teeth: upper left 2nd premolar, 1st molar, and lower left 1st premolar.

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

Fig. 4. Post-treatment facial photographs

Fig. 5:

Post-treatment intraoral photographs document the final alignment with an implant-supported prosthesis in the upper left posterior quadrant.

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

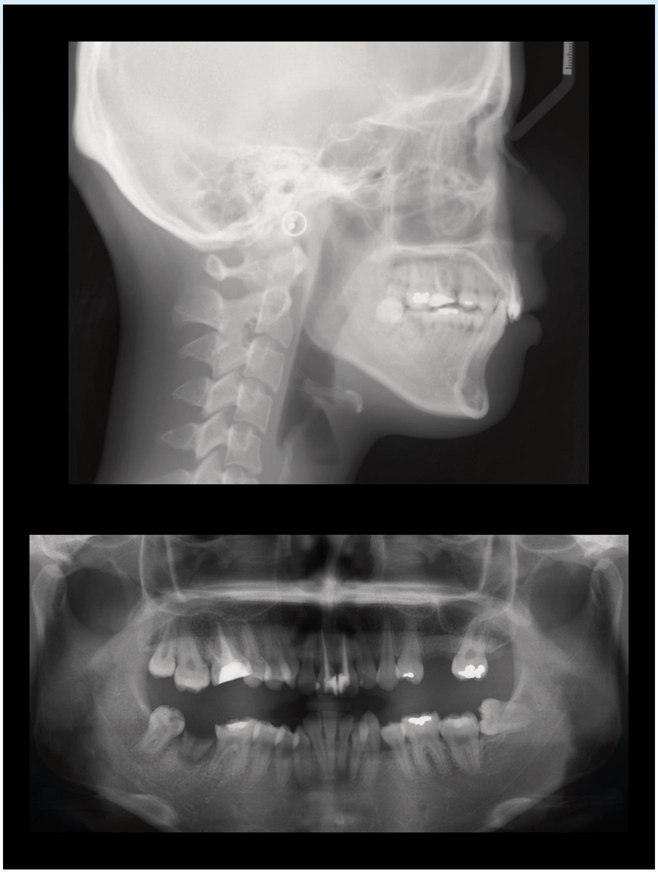


Fig. 7:

Pre-treatment lateral cephalometric and panoramic radiographs show a horizontally impacted lower left 3rd molar, and endodontially treated upper central incisors.

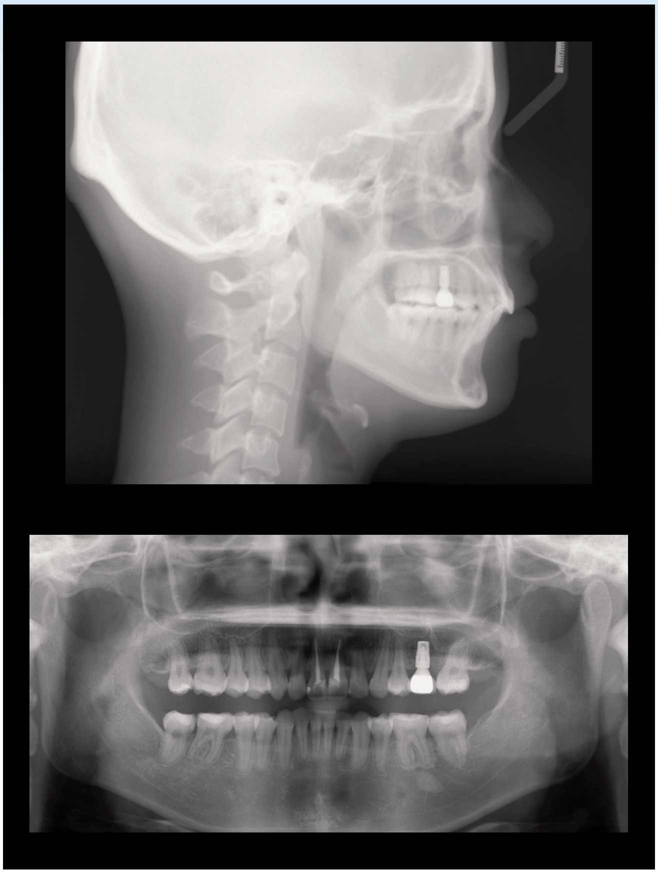


Fig. 8:

Post-treatment lateral cephalometric and panoramic radiographs document the final alignment with an implant supported crown in the upper left posterior quadrant.

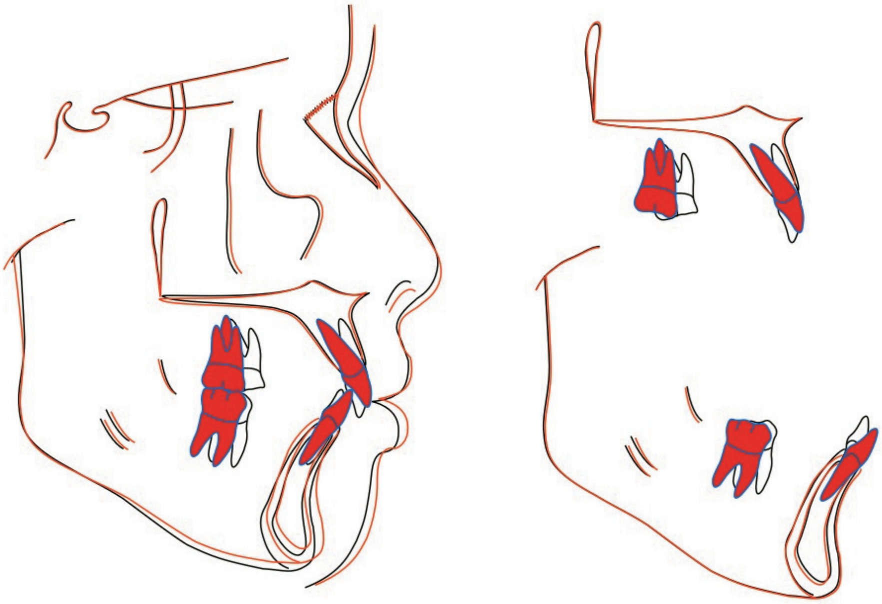


Fig. 9:

Superimposed cephalometric tracings reveal the changes in molar and incisor positions. Note the mandible was rotated slightly counterclockwise decreasing the vertical dimension of occlusion.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	88°	87.5°	0.5°
SNB°	81°	81.5°	0.5°
ANB°	7°	6°	1°
SN-MP°	32°	30°	2°
FMA°	26°	24°	2°
DENTAL ANALYSIS			
U1 TO NA mm	0.5 mm	2 mm	1.5 mm
U1 TO SN°	96°	113°	17°
L1 TO NB mm	5 mm	6 mm	1 mm
L1 TO MP°	89°	100°	11°
FACIAL ANALYSIS			
E-LINE UL	0 mm	-0.5 mm	0.5 mm
E-LINE LL	1.5 mm	1.5 mm	0 mm

■ Table 1: Cephalometric summary

Diagnosis

Skeletal:

1. Skeletal Class II: SNA 88°, SNB 81°, ANB 7°

2. Mandibular plane angle within normal limits (*WNL*): SN-MP 32°, FMA 26°

Dental:

1. Molar relationship: Class II on the right side, missing upper left 1st molar

2. Canine relationship: Class II on the right and Class I on the left

3. The overjet was 3.5 mm and the overjet was 8mm (*100% of lower incisor height*) with palatal impingement

4. Crowding: -16 mm in the upper arch, and -10 mm in the lower arch

5. Residual roots were retained for the hopeless mandibular right 2nd molar

6. Missing teeth: Maxillary left 2nd premolar and 1st molar, and mandibular left 1st premolar

7. Endodontically treated maxillary right 1st molar and 2 maxillary central incisors

8. Horizontally impacted mandibular left 3rd molar

9. Maxillary dental midline was 3 mm left of the facial midline

Facial:

Acceptable profile with slightly protrusive lower lip

The ABO Discrepancy Index (*DI*)[1] was 36 as shown in the subsequent worksheet.

Specific Objectives of Treatment

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

- A - P: Slight protrusion
- Vertical: Decrease
- Transverse: Maintain

Dentition

- Remove all carious teeth and replace unesthetic amalgam restorations

- Extract teeth with hopeless or poor prognosis, and close spaces if possible
- Relieve maxillary and mandibular crowding
- Prepare an adequate site for an implant-supported crown to replace the missing left maxillary 1st molar
- Correct the midline
- Establish normal overjet and overbite
- Achieve an Angle Class I molar and canine relationship bilaterally

Facial Esthetics: Maintain

Treatment Plan

After careful review of the patient's facial profile, dental, and occlusal problems, the treatment plan was as follows:

1. Restore the carious teeth before starting orthodontics treatment
2. Extractions: upper right 1st molar, residual roots of lower right 2nd molar, lower left horizontally impacted 3rd molar
3. Full fixed orthodontic appliance
4. Anterior bite turbos on maxillary central incisors for deep bite correction
5. Protract upper right 2nd and 3rd molars, as well as the lower right 3rd molar to close edentulous spaces
6. Protract upper left 2nd molar and leave appropriate space on the mesial for an implant-supported prothesis
7. Orthodontic bone screw(*s*) to assist in correction of the midline deviation (*if needed*)
8. Establish a Class I pre-prosthetic occlusion with adequate protrusive guidance and canine protected lateral excursions
9. Detailed bending and settling elastics to produce the final occlusion
10. Sinus-lift augmentation may be needed for maxillary left implant placement
11. Once the implant has integrated, restore with a crown
12. Ceramic crowns for endodontically treated upper central incisors
13. Retain the corrected malocclusion using clear overlay retainers for both the maxillary and mandibular arches

Appliances and Treatment Progress

After routine dental care and the prescribed extractions were completed, an 0.022" slot Damon D3MX bracket system (*Ormco*) was bonded on both arches with standard torque brackets on both the maxillary and mandibular anterior teeth (*Fig. 10*). The archwire sequence for the upper arch was .014" CuNiTi, .014"x.025" CuNiTi, .017"x.025" TMA, .019"

■ *Fig.10:*

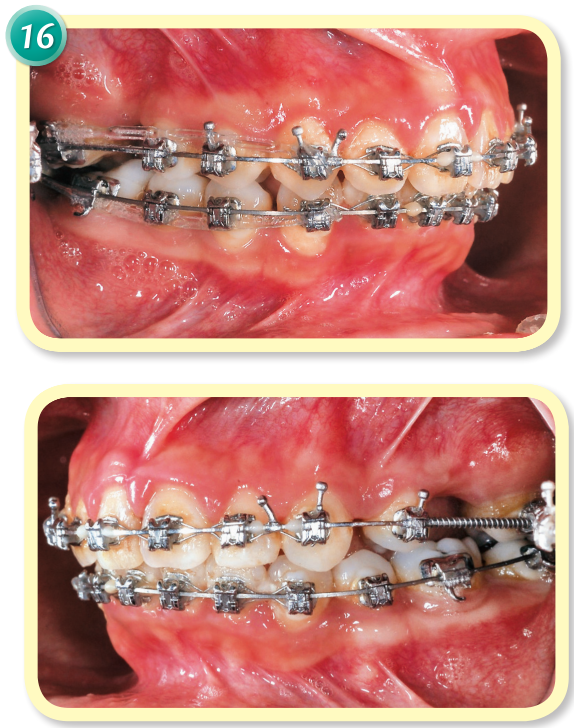
Standard torque brackets were used for all teeth in both arches.

■ *Fig. 11:*

After 10 months of initial alignment, composite resin bite turbos (bite opening occlusal stops) were placed on the palatal surfaces of the maxillary central incisors.

x0.25" SS. The lower arch wire sequence was .014" CuNiTi, .014"x.025" CuNiTi, .017"x.025" TMA, .016" x0.25" SS. In the 10th month of treatment, composite resin bite turbos were placed on the palatal surface of the maxillary central incisors (*Fig. 11*) to intrude both maxillary and mandibular incisors. During intrusion, the upper and lower archwires were .014" x.025" CuNiTi, and the patient was instructed to wear Class II elastics (*Parrot 5/16", 2oz*) full time, bilaterally from the maxillary 1st premolars to mandibular 1st molars.

In the 14th month, the maxillary archwire was changed to .019"x0.25" SS, whilst the mandibular archwire was changed to .017"x.025" TMA. Two



■ *Fig. 12:*

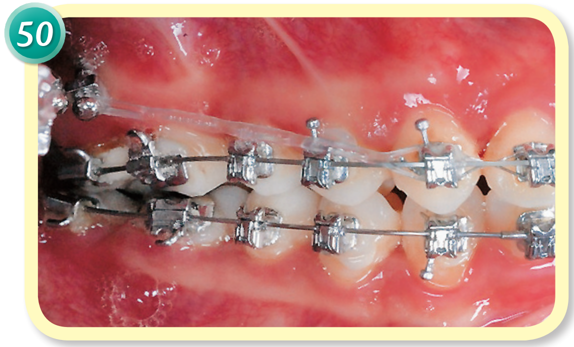
Power chains were used to close all extraction spaces except in the upper left quadrant where an open coil spring was used to maintain the site for an implant.

crimpable hooks were attached bilaterally to the maxillary archwire between the lateral incisors and canines (*Fig. 12*), and the Class II elastics from the upper arch wire hooks to the lower terminal molars were upgraded (*Fox 1/4", 3.5 oz*). Power chains were used to close the extraction sites for the maxillary right 1st molar and mandibular right 2nd molar extraction sites. After 15 months of treatment (*including 7 months of missed appointments due to the patient's job relocation*), the two extraction spaces were closed. The implant site between the maxillary left 1st premolar and 2nd molar measured 5 mm in the 29th month, so a NiTi open coil spring was utilized to create an additional 3 mm of space for the future implant placement (*Fig. 13*).

■ *Fig. 13:*

The anterior bite turbos were removed when the desired overjet and overbite had been achieved. The length of the open coil spring in the maxillary left 2nd premolar area was increased to create a larger space for the implant.

The treatment was paused for 1 year because of the patient's oversea business commitments. In the 42th month of treatment, bracket repositioning was performed as indicated by the panoramic films, and both archwires were decreased in size: .014"x.025" CuNiTi for the upper and .018" CuNiTi for the lower. In the 49th month of treatment, a miniscrew (*2x12 mm, OrthoBoneScrew, Newron's A, Inc.*) was inserted into the maxillary right infrazygomatic crest to correct the midline discrepancy (*Fig. 14*). The upper midline had shifted about 1mm to the left, despite a unilateral right Class II elastic worn for the preceding 7 months.



■ *Fig. 14:*

A miniscrew was inserted in the upper right infrazygomatic crest (IZC) to achieve midline correction and Class I occlusion.

After 6 months of treatment, the bimaxillary archwires were progressively changed to .017"x.025" TMA, the occlusion had been adequately corrected, and the space for the implant site had been well prepared for placement.

Implant Placement

As the implant was developed, the floor of the maxillary sinus decreased. A pre-operative CT scan was indicated (*Fig. 15*) to plan the implant surgical procedure. The bone height was about 9 mm on the buccal side and 7.5 mm on the palatal side

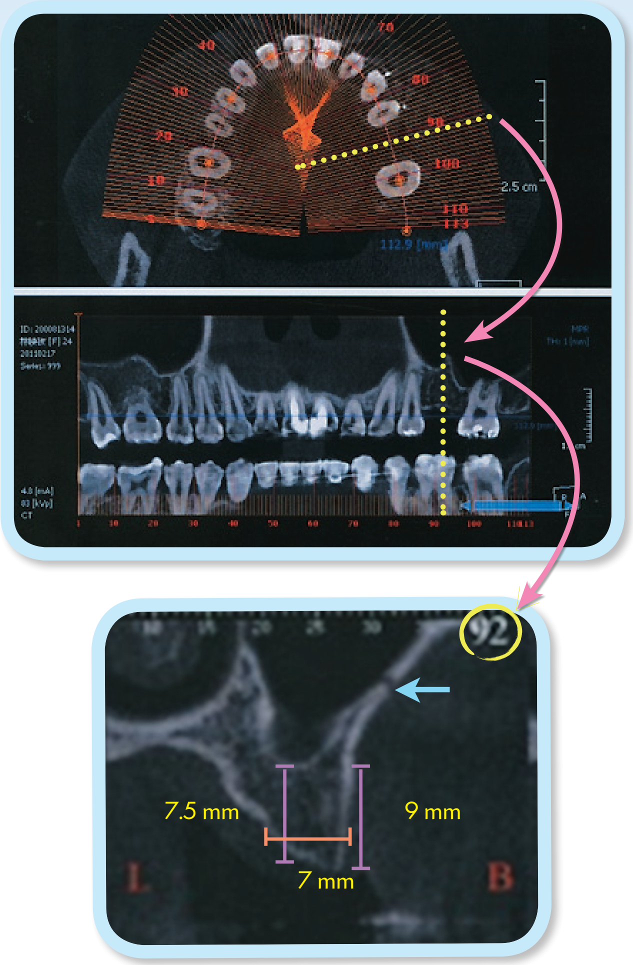


Fig. 15:

Slices view of the CBCT scan showed that the bone height was about 9 mm on the buccal side and 7.5 mm on the palatal side of the implant site. Note the blood vessel tract (blue arrow) demonstrating that this would be a high risk site for sinus augmentation with the lateral window technique.

consistent with the bucco-lingual slope of the alveolar ridge. A flapless implant surgery technique, with an osteotome sinus floor elevation, was indicated for the implant placement, and the patient was so informed before the surgery. A surgical stent was designed following the 2B-3D rule[1] for precise implant placement in all three dimensions.

After injecting the local anesthesia, the surgical stent was fitted into position and a periodontal probe was used to penetrate the soft tissue to make a puncture (*Fig. 16*) for marking the central position of the future implant. A soft tissue

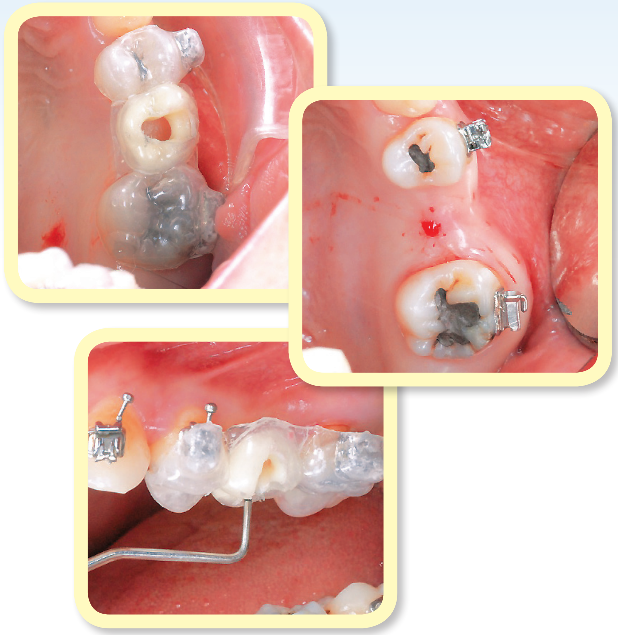


Fig. 16:

The surgical stent was fitted into position and a periodontal probe was used to penetrate the soft tissue to make a gingival puncture for marking the central position of the future implant.

punch (*Ø4.0 mm*) was utilized to make a circular incision through the gingiva. A core of soft tissue was then removed from the crestal bone with a surgical curette (*Fig. 17*). Before the osteotomy, a soft tissue thickness of 3 mm was measured using a periodontal probe (*Fig. 18*).

The surgical stent was repositioned for the initial osteotomy to guide the first lancer drill to 10 mm in depth (*7 mm bone depth and 3 mm soft tissue depth*) (*Fig. 18*). Then a surgical guide pin (*Ø2.0 x 10 mm*) was placed and a periapical X-ray was taken (*Fig. 19*) to check the remaining distance to the sinus floor and the mesiodistal angulation of the implant site preparation. Sufficient bone was available for further drilling to receive an implant fixture Ø4.3 x 8 mm in size. The implant site osteotomy was continued with twist drills following the manufacturer's instructions to produce an osteotomy that is 3.9 mm in diameter and 11 mm in length, with 8 mm bone depth and 3 mm of soft tissue thickness (*Fig. 19*). Tactile feedback of bone density was carefully noted during the osteotomy to prevent accidental sinus floor perforation.

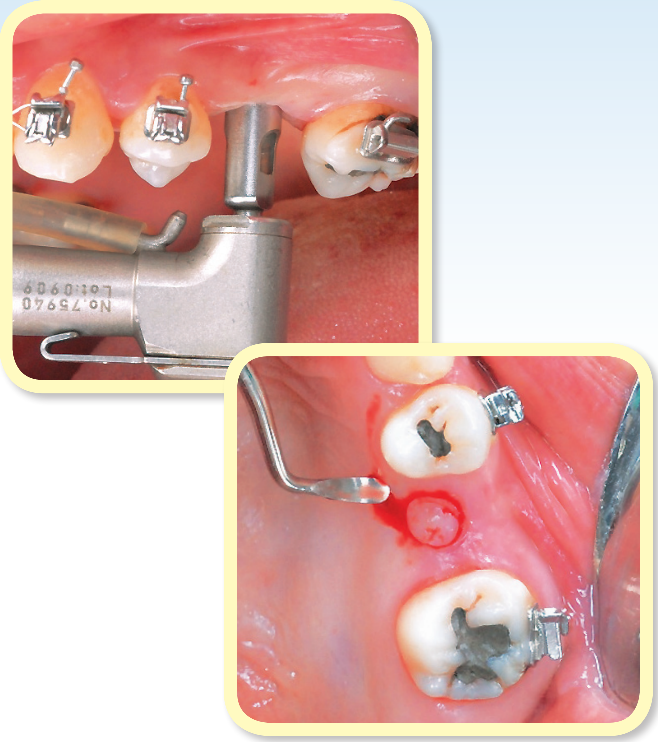


Fig. 17:

A soft tissue punch cut a circular incision through the gingiva. The core of soft tissue was then removed from the crestal bone with a surgical curette.

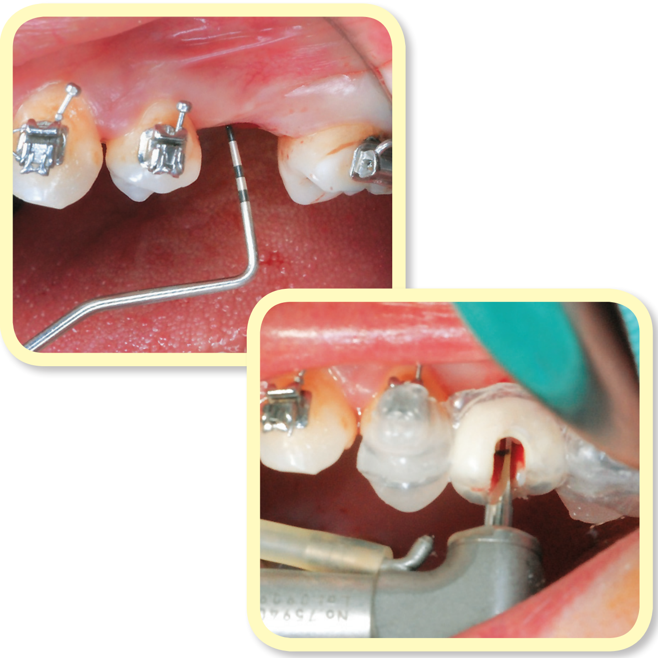


Fig. 18:

The soft tissue thickness was measured to be 3 mm before the implant placement. Then the surgical stent was fitted again to guide the first lancer drill for an initial osteotomy that was 10 mm in depth.

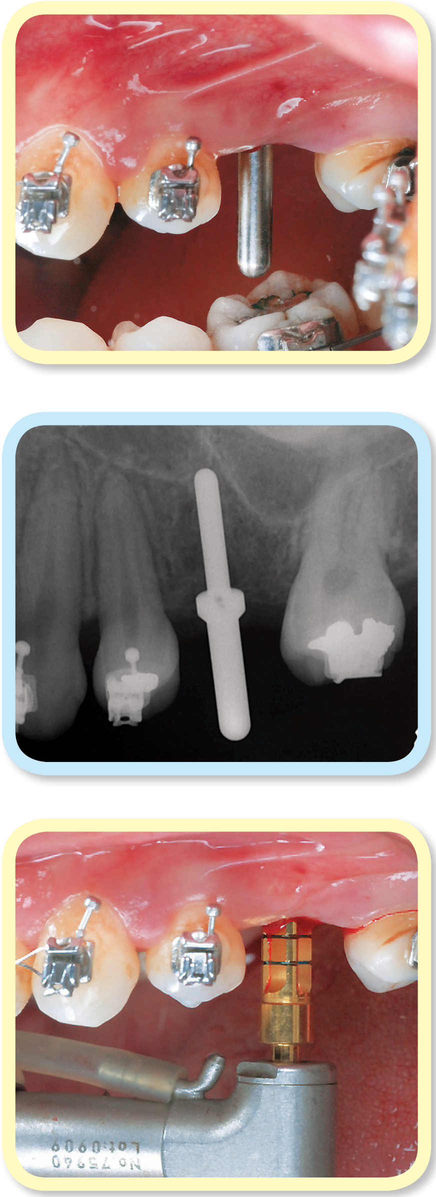


Fig. 19:

After the initial osteotomy, a surgical guide pin was placed and a periapical X-ray was taken to check the remaining distance to the sinus floor as well as the mesiodistal angulation of the osteotomy.

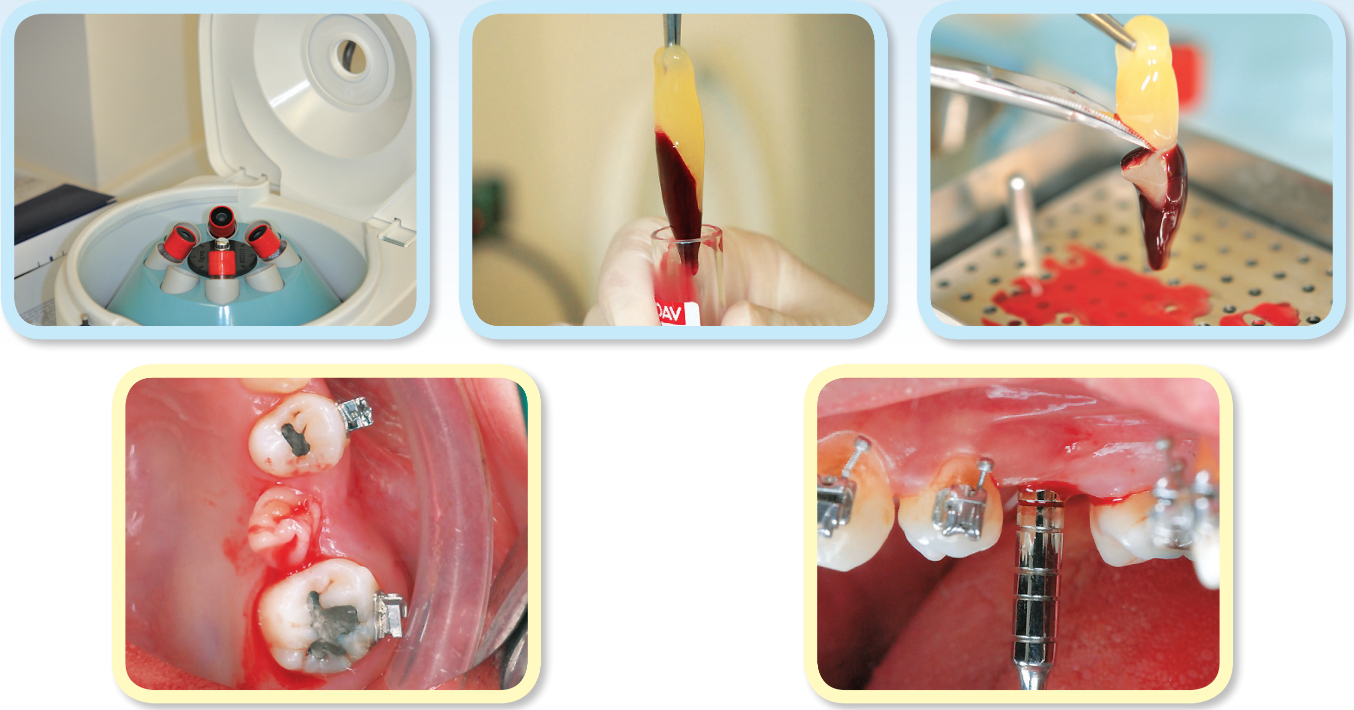


Fig. 20:
The PRF was prepared with a centrifuge and then inserted into the base of the prepared implant site.

During the surgery, about 8 ml of the patient's whole venous blood was drawn into 10 ml glass-coated plastic tubes without anticoagulant and immediately centrifuged (*Process PC O2 centrifuge*) at 3000 rpm for 10 minutes (*Fig. 20*). The specimen settled into 3 layers: upper straw-colored acellular plasma, the red-colored lower fraction containing red blood cells, and the middle fraction containing the fibrin clot, deemed the platelet-rich fibrin (*PRF*) layer. The upper straw-colored layer was removed and the middle fraction containing the PRF was collected gently, with sterilized cotton pliers from 2 mm below the lower dividing line (*Fig. 20*). Before the implant placement, the PRF was inserted into the prepared implant site, and an osteotome (*Fig. 20*) (*Ø3.8 mm, Salvin®*) was used to push it axially into the apical third of the prepared implant site. PRF was used to ensure sinus membrane integrity when

Fig. 21:
The implant fixture was installed, along with a 5 mm healing abutment.

the implant was inserted, as well as to promote the subsequent healing process.

The implant fixture (*Fig. 21*) (*Ø4.3 x 8 mm, A+ system, MegaGen® Taiwan*) was installed, and a 5 mm healing abutment was connected to it. A periapical X-ray was taken to check the position and angulation of the implant, to confirm the integrity of the sinus membrane, and to make sure that the healing abutment had achieved the correct position. The postoperative panoramic radiograph and CT scan were taken 2 and 5 weeks after the surgery respectively (*Fig. 22*).

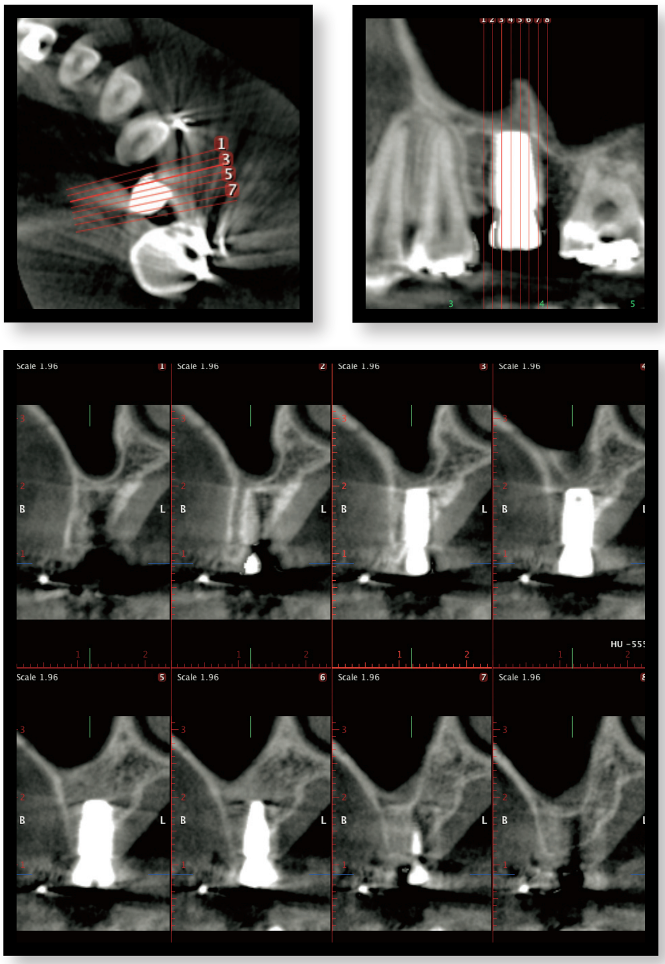


Fig. 22:

Post-operatively, the slice view of the CBCT images (below) showed that the buccal bone thickness was 2 mm which is desirable for the longterm success of the implant-supported prosthesis.

Orthodontic Finishing

Bracket repositioning was performed as indicated by sequential panoramic films during several appointments. The right side Class II elastics and power chains hung on the miniscrew were used to Bracket repositioning was performed as indicated by sequential panoramic films during several appointments. The right side Class II elastics and power chains anchored by the miniscrew to improve the occlusal relationship. Chipmunk 1/8", 3.5 oz elastics (*Ormco*) were applied from a drop hook attached to the maxillary left 1^{st} premolar bracket to a button on the lingual surface of the mandibular left 2^{nd} premolar, to correct the occlusal contacts and buccolingual inclination.

In the 64^{th} month of treatment, reshaping the contour of the maxillary central incisors, and the mandibular, central and lateral incisors was performed (*Fig. 23*) for two reasons: 1. control the anterior teeth from flaring, and 2. change the triangular shaped central incisors to a more pleasant rectangular contour, and to eliminate the dark triangles of interdental areas.

After 67 months of treatment, all appliances were removed. Upper and lower clear overlay retainers were delivered for both arches, and the patient was scheduled for the implant prosthesis fabrication.

■ *Fig. 23:*

The anterior teeth are shown before (left) and after (right) reshaping.

Implant Prosthesis Fabrication

Three weeks after removal of the orthodontic appliances, 10 months after the implant was placed, the healing abutment was removed and the surrounding tissue thickness was measured to be 3 mm thick (*Fig. 24*). A 2.0 mm cuff height multi-post abutment (*Ø5.0 mm, 5.2 mm post height and 2.0 mm cuff height*) was selected for prosthesis fabrication. The post height of the abutment was then adjusted extraorally with a diamond bur mounted on a high speed hand piece, to provide 1.5 mm inter-occlusal clearance for the fabrication of a zirconia crown (*Fig. 25*). The abutment level impression technique was chosen. Before taking an impression, the abutment screw was torqued to 35-N-cm (*Fig. 25*) with a screw driver and a torque ratchet. Double core packing[2] (*Figs. 26A and 26B*) began with a thinner (*KnitTrax™, #00*) gingival retraction cord for soft tissue compression, and proceeded with a thicker cord (*KnitTrax™, #1*) for soft tissue reflection using a cord packing instrument. The screw access hole for the abutment

■ *Fig. 24:*

After removing the healing abutment, the surrounding soft tissue thickness was found to be 3 mm thick. This is an important measurement for selecting the correct prosthetic abutment.

■ *Fig. 25:*

The abutment was adjusted to provide 1.5 mm of inter-occlusal clearance (left) for the future zirconia all ceramic crown, and it was then torqued to 35 N-cm (right).

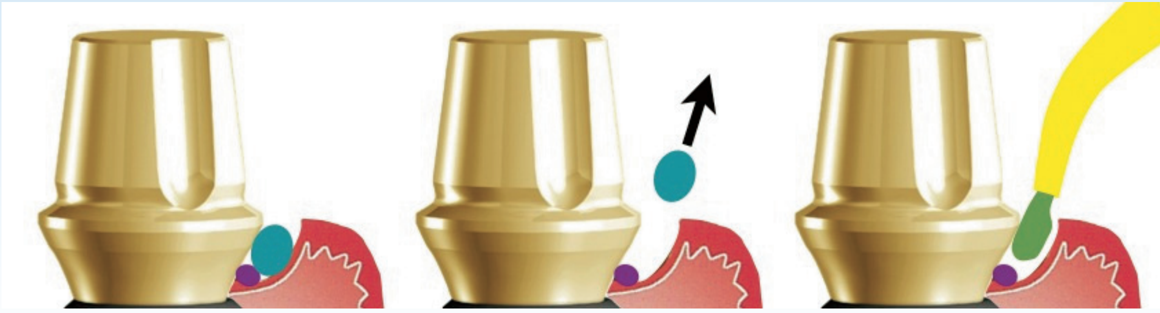


Fig. 26A:
Schematic drawings illustrate the double core packing method (left). The impression was carried out with only the first compression cord (purple) left in the base of the gingival sulcus (middle drawing). In the right illustration, the large diameter gingival retraction cord (Blue-green) was removed (black arrow), and the impression material (green) was injected into the sulcus with a syringe (yellow).

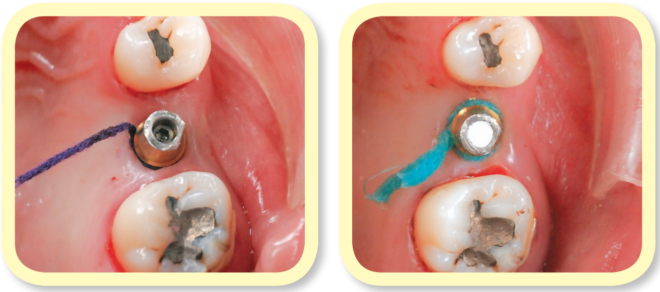


Fig. 26B:
Clinical photographs show the double core packing method: a thinner gingival retraction cord is inserted first for soft tissue compression deep in the sulcus (left), and a thicker cord (right) is packed into the sulcus for soft tissue reflection.

Fig. 27:
A direct impression was carried out with polyvinyl siloxane impression material (Left) and poured in type IV dental stone for prosthesis fabrication.

was then sealed with a small cotton pleget and temporary cement (*Caviton*, GC). A direct impression was made with polyvinyl siloxane impression material leaving only the first compression cord in the gingival sulcus (*Fig. 27*).

The impression was poured in type IV dental stone, and the casts were subsequently mounted on an articulator using an appropriate check-bite record. A zirconia all ceramic crown was fabricated by a commercial laboratory (*Figs. 27 and 28*). After completion of the final prosthesis, the marginal integrity was verified with a dental explorer and appropriate tightness of the contact area was confirmed with dental floss. After clinical adjustment

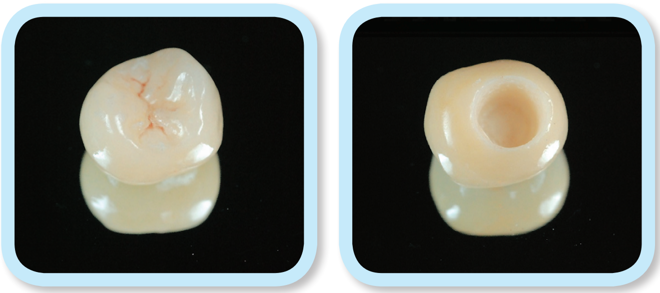


Fig. 28: *Zirconia all ceramic crown*

and verification of fit and occlusion, the permanent crown was luted into place with temporary cement (*Fig. 29*).

After delivery of the implant prosthesis, all old amalgam restorations were replaced with more esthetic composite resins (*Fig. 30*). Further prosthetic treatment, using all-ceramic crowns on the endodontically treated maxillary central incisors was proposed, but the patient declined because she was satisfied with the current treatment outcome (*Fig. 31*), and had financial concerns regarding further treatment.

Fig. 29:

The permanent crown was completed and luted into place with temporary cement.

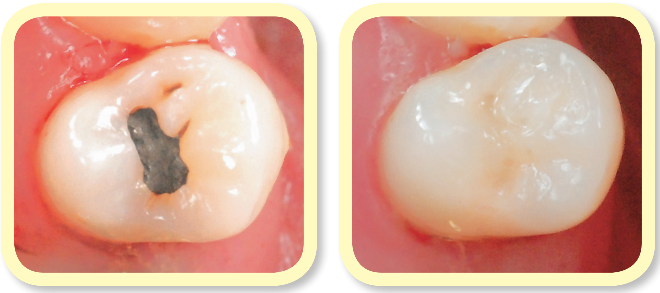


Fig. 30:

After delivery of the implant-supported crown, amalgam restorations were replaced as indicated with more esthetic composite resin.

Fig. 31:

A post-treatment 45° facial photograph shows the facial and dental esthetics achieved.

Results Achieved

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

- A - P: Maintained
- Vertical: Decreased by rotating the mandible counterclockwise 2°
- Transverse: Maintained

Maxillary Dentition

- A - P: Incisor roots were retracted
- Vertical: Incisors slightly intruded
- Inter-molar / Inter-canine Width: Expanded

Mandibular Dentition

- A - P: Incisors moved anteriorly 1-2mm
- Vertical: Incisors intruded ~3mm
- Inter-molar / Inter-canine Width: Expanded

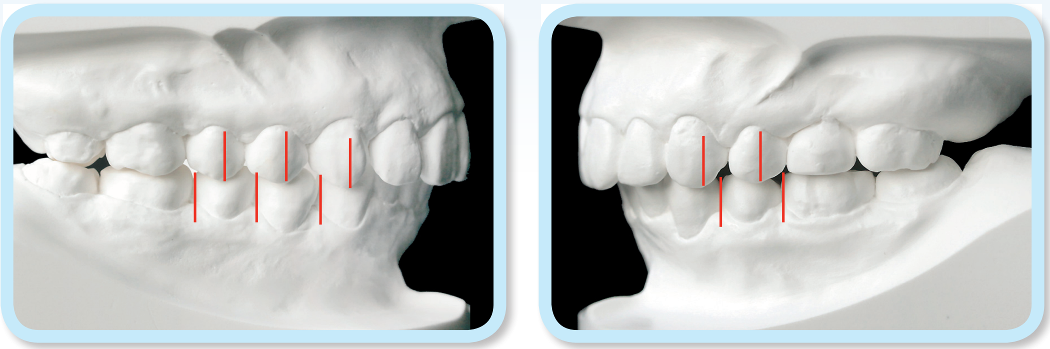
Facial Esthetics: Maintained (Fig. 9).

Retention

Upper and lower clear overlay retainers were delivered. The patient was instructed to wear them full time for the first 6 months and nights only thereafter. Retainer home care and maintenance instructions were provided.

Final Evaluation of Treatment

The ABO Cast-Radiograph Evaluation (*CRE*) score[3] was 20 points. The major discrepancies were occlusal relationships (*Fig. 32*) (*9 points*), and occlusal contacts (*3 points*). The asymmetric extractions and



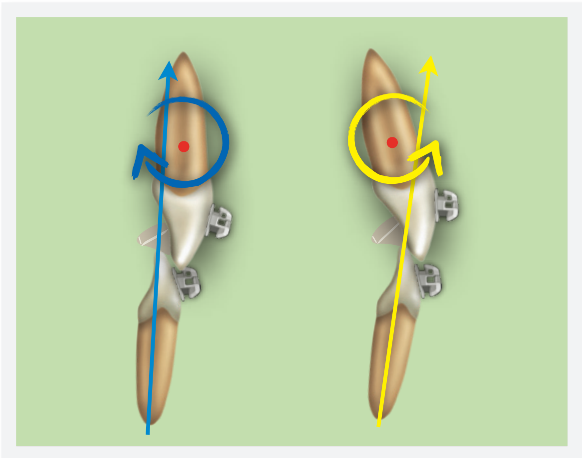
■ *Fig. 32:*

The asymmetric extraction pattern and unfavorable positions of some missing teeth contributed to the compromised interdigitation of the buccal segments.

positions of the missing teeth appeared to be the major factors contributing to the compromised final occlusion. Details of the CRE scores are presented in the The smile esthetics were substantially improved by relieving crowding of the maxillary anterior teeth, establishing a proper gingival margin display, and correcting the dental midline. Occlusal function was improved by providing adequate protrusive guidance and proper bilateral occlusal contacts of the posterior teeth. Overall, there was a significant improvement in dental esthetics and function. The patient was satisfied with the treatment outcome (*Fig. 31*).

Discussion

The deep overbite correction is a prominent issue in orthodontics. Graber has defined "*deep bite*" as a condition of excessive overbite, where the vertical measurement between the maxillary and mandibular incisal margins is excessive when the mandible is brought into habitual or centric occlusion.[4] It is customary to diagnose deep bite when the incisor overlap exceeds one-third of the crown height of the lower incisors. Dawson[5] felt that deep anterior overbite was only a problem if there are no stable holding contacts. For the present



■ *Fig. 33:*

It is important to correct the axial inclination of a palatally tipped maxillary central incisor before applying a bite turbo. Otherwise the intrusive force from occlusion of the lower incisors generates an unfavorable moment tending to rotate the upper clockwise (left). Once the upper incisor inclination is corrected, occlusion on the bite turbo produces a favorable moment for further correcting the axial inclination of the maxillary incisor (right).

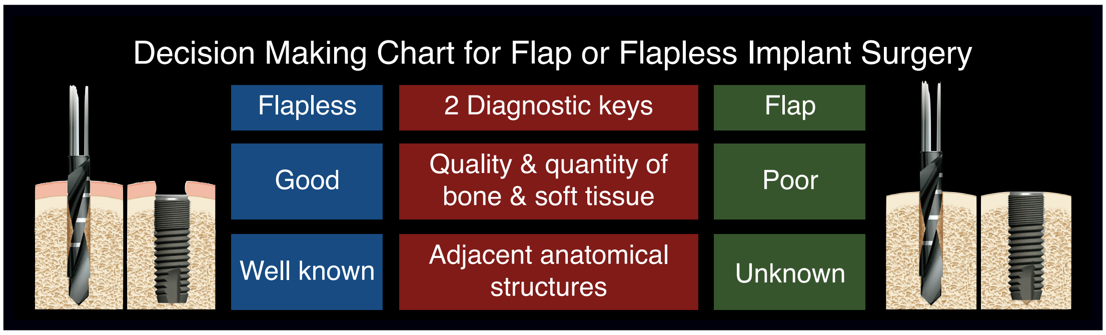
patient, the mandibular incisors were impinging on the palatal gingiva of the maxillary central incisors, which is evidence for an unstable relationship that may progress if posterior centric stops continue to deteriorate. The endodontically treated maxillary central incisors are at risk unless the unstable intermaxillary relationship is corrected.

There are four treatment options for correcting Class II division 2, deepbite malocclusions: 1. extrude posterior segments, 2. intrude maxillary incisors, 3. intrude mandibular incisors, and 4. flare the maxillary and/or mandibular incisors.[6] The present patient had a normal mandibular plane angle, so the first treatment option was not suitable. However, the last three options were viable approaches.

The appliances used to correct the deep bite were bite turbos to intrude the upper and lower incisors, and brackets with increased torque to flare-out the maxillary anterior teeth. Furthermore, bite turbos open the posterior occlusion to facilitate arch leveling, and improve the effect of early light elastics for Class II correction. The posterior teeth may extrude when using bite turbos combined with Class II elastics usage, thereby increasing the mandibular plane angle. However, the normal mandibular plane angle of the current patient provided some tolerance for increasing the mandibular plane angle. On the contrary, protraction of the upper and lower right posterior teeth may help control the mandibular plane angle. For the current patient the mandibular plane angle decreased 2° (*Fig. 9, Table 1*) which may be related to molar protraction, as well as to improved bilateral occlusal function.

Posteriorly-inclined upper incisors are a problem when using bite turbos.[7] The retroclined maxillary incisors must be corrected first, or the problem will worsen because of the biting force due to lower incisor occlusion tends to rotate the upper incisors clockwise (*Fig. 34*). This was why the bite turbos were not bonded early in the treatment, but 10 months later.

Flaring of lower incisors is a common complication



■ *Fig. 34:*

Choosing between a flapless or flapped approach depends on quality and quantity of both bone and soft tissue, as well as a detailed knowledge of the anatomy of critical structures near the implant site.

for Class II elastics. This problem can be controlled by using lower incsior brackets with decreased torque. Another option is bilateral infrazygomatic crest miniscrews to correct the Class II relationship rather than depending on Class II elastics.

The mesio-distal space maintained for the maxillary left implant site was based on multiple factors: tooth position, occlusal relationship, and bucco-lingual bone thickness. The position of the missing teeth and the opposing dentition (*mandibular left 1st molar*) indicated that the implant-supported prosthesis should be a molar-sized crown. The final decision of mesio-distal width for the implant site should be determined after the finish occlusion is nearly achieved. The alveolar ridge of the implant site had a bucco-lingual slope and insufficient bone thickness for a large diameter (> *5 mm*) implant placement. The implant size chosen in this case was 4.3 mm in diameter. An implant smaller than 4.3 mm should be placed deeper in the bone to achieve an appropriate emergence profile as well as to resist flexure due to functional loading. The predicted future implant size and the desired occlusal relationship (*Class I molar*) indicated that an 8 mm mesio-distal space for implant placement was reasonable.

Flapless surgical technique, as a method for dental implant placement, is gaining popularity among implant surgeons. Advanced 3D dental imaging, particularly with cone beam computed tomography (*CBCT*), treatment planning software and computer generated surgical guides, the flapless implant surgical approach has a predictable outcome with a high success rate, especially in properly selected cases.[8] Flapless implant surgery has numerous advantages, including preservation of the vessels around the implants, maintenance of the original mucosal form around the implants, and retention of hard tissue volume at the surgical site. This method also shortens the length of the surgery, improves patient comfort, and accelerates recovery.[9] Flapless surgery has some significant limitations: 1. poor control of precise drilling depth because of difficulty in determining the precise entry point into the alveolar bone, 2. inability to preserve keratinized gingiva with a tissue punch perforation, and 3. poor ability to assess the precise osteotomy point of entry. Thus flapless surgery is primarily for implant sites where there is sufficient quantity and quality of bone, as well as a substantial quantity of keratinized gingiva.[10]

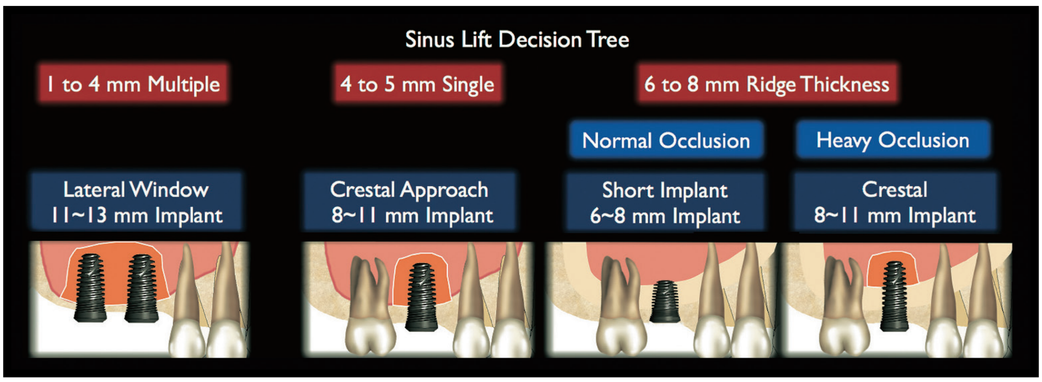
In this case, the surgical site was the maxillary left 2nd premolar area, which is less esthetically demanding and the chance of nerve damage is minimal. There was sufficient keratinized gingiva and no buccal undercut was detected on the alveolar bone surface. Some difficulties were apparent such as the bucco-lingual slope of the alveolar ridge and limited bone height, so it was essential to carefully plan the surgery to achieve a successful outcome. Surgical stent fabrication is important for flapless implant surgery to achieve a precise mesio-distal, bucco-lingual, and axial position of the implant. Precisely determining soft tissue thickness is an essential step for following the 2B-3D rule.1 There are 2 ways to measure the soft tissue thickness: 1. indirect and 2.

direct. An indirect approach is to use a radio-opaque material, such as zinc oxide eugenol temporary cement, applied to the outer surface of the surgical stent to illustrate the contour of the future prosthesis. Another radio-opaque material, high viscosity impression putty, can be inserted into the inner space of the stent producing a white outline of the soft tissue in a 3D image. A direct method is bone sounding using a periodontal probe can be carried out before the surgery to detect the soft tissue thickness.

According to Chang's Sinus Lift Decision Tree (*Fig. 35*),[11] a short implant of 6-8 mm was indicated for a patient with 6-8 mm bone height and normal occlusion. However, the limited bone height (*9 mm buccally and 7.5mm palatally*) was a concern for an 8 mm implant. Particularly for the flapless approach, it was very important to focus on the tactile feedback of bone density when performing the osteotomy to prevent the sinus floor from being perforated. The apical diameter of the implant fixture was larger than the corresponding osteotomy tool that prepared the site. This approach provides for better initial stability, but may have caused damage to the sinus membrane when the implant was seated, so PRF was used as a cushion to prevent sinus floor perforation.

Platelet-rich fibrin (*PRF*) is a simple, natural, and inexpensive blood product that is prepared by centrifugation of whole blood drawn into a tube without anticoagulant. PRF is moderately strong and is easy to handle.[12] The success of this technique depends on the time gap between the blood collection and its transfer to the centrifuge, and it should be done in the least time possible.[13]

PRF is an autologous fibrin matrix that is rich in platelets, leukocytes, and growth factors. The strong fibrin matrix can protect the denuded wound tissues and provide a scaffold for cell migration during the tissue repair process. Furthermore, fibrin also serves as a reservoir for cytokines and growth



■ *Fig. 35:*

Management of the maxillary sinus primarily depends on residual bone height, implant length, and amount of bone grafting required. It is also important to evaluate the probable loading of the implant-supported prosthesis.

factors that ensure their slow release. Many studies have used PRF for various procedures and found it to accelerate soft and hard tissue healing, such as periodontal surgery, implant placement and sinus floor augmentation.[12] There also are some studies which report that using PRF as sole filling material is a reliable surgical option promoting natural bone regeneration both in osteotome-mediated or lateral window sinus floor elevation with simultaneous implantation.[12, 14-17] The PRF used for the present patient to act as a bone cushion to ensure sinus floor integrity when the oversized implant was seated. An additional benefit was to promote the healing process.

The post-treatment CT images showed that the sinus membrane was intact and the implant appeared to be placed right on the bone septum. The 2 mm buccal bone thickness was sufficient for an adequate emergence, which strictly followed the 2B-3D rule.[1] However, there some bone dehiscence on the palatal surface which may be a consequence of the sloping alveolar ridge before implant placement. This anatomical problem may result in some implant fixture exposure in the future. Fortunately, the implant is located in a less esthetically demanding area, and the thick palatal soft tissue is more resistant to soft tissue clefting. In retrospect, a more predictable, longterm outcome may have been achieved by either placing the implant 1~1.5 mm deeper with simultaneous sinus floor elevation, or using open flap surgery to perform bone expansion. However, the more invasive surgical procedure damages implant site tissues, complicating the healing process, and is less comfortable for the patient.

A major cause of failure for implant-supported prostheses after occlusal loading is attributed to occlusal overload.[18]

Therefore, appropriate occlusal adjustment for an implant-supported prosthesis is essential for its long-term prognosis. Klineberg et al.[19] recommend axial loading of implants by cradling supporting cusps in the opposing tooth central fossa, and constructing an occlusal surface with a wide fossa, reduced cusp inclination and wide grooves. Single-tooth implant crowns should have 10 μm shimstock clearance at the intercuspal position in centric occlusion. Posterior contact during excursive movements is discouraged.[19] According to Weinberg and Kruger,[20] every 10° increase in cusp inclination, there is approximately a 30% increase in lateral loading of the implant/prosthesis. When comparing photos taken before and after the occlusal adjustment (*Fig. 36*), the implant crown buccal cusp slope and height were constructed to decrease the susceptibility for occlusal trauma.

Conclusion

Dental treatment for adult patients is usually complicated and time-consuming because of compromised oral hygiene, multiple carious lesions, and acquired malocclusion. To ensure

Fig. 36:

The height of the buccal cusp on the implant-supported prosthesis was decreased to minimize lateral loading and the potential for occlusal trauma during functional excursions of the mandible.

the long-term success, the treatment plan must consider both facial esthetics and occlusal function. Preprosthetic orthodontic treatment was essential for redistributing space and achieving an acceptable occlusion. Soft tissue and dental esthetics when smiling was dramatically improved.

Flapless implant surgery results in reduced post-operative bleeding, patient discomfort, surgical placement time, and healing interval before restoring occlusion. However, this method requires more thorough treatment planning and surgical skill compared to conventional methods. Advancements in digital imaging and computer guided surgery are rapidly simplifying the flapless method.

The outcome for the current case was gratifying to both the patient and clinician. However, it is important to carefully assess and quantify the results to identify deficiencies. Focusing on the pattern of residual problems helps develop a more simplified methodology to produce consistent longterm results. No case is perfect, so analyzing details is an opportunity to develop a more predictable treatment philosophy to guide interdisciplinary care.

Acknowledgment

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Discrepancy Index Worksheet

Total DI Score 36

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 = 5

ANTERIOR OPEN BITE

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

Total = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

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

Total = 7

OCCLUSION

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

Total = 4

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 1

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° 0 = (4) pts.

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

Each degree > 6° 1 x 1 pt. = 1

SN-MP

≥ 38° = 2 pts.

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

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 5

OTHER (See Instructions)

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

Identify: Molar protraction

Total = 7

IMPLANT SITE

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

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

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

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

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

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

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

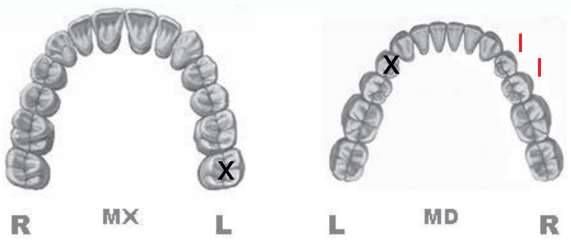
Total = 5

Cast-Radiograph Evaluation

Total CRE Score 20

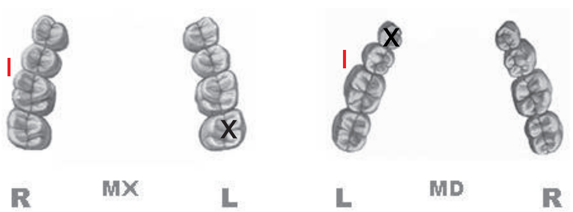
Alignment/Rotations

2



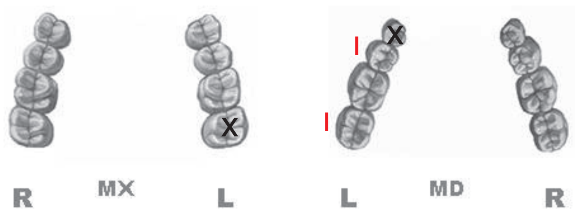
Marginal Ridges

2



Buccolingual Inclination

2

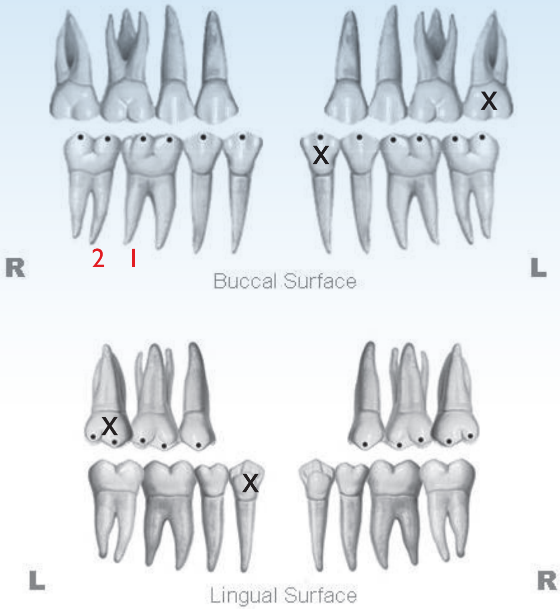


Overjet

0

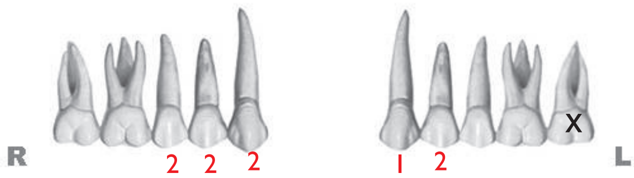
Occlusal Contacts

3



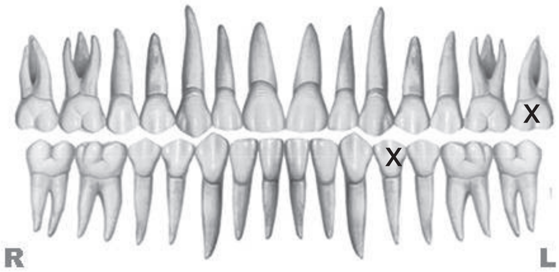
Occlusal Relationships

9



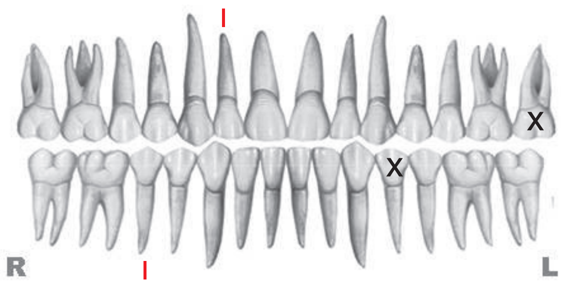
Interproximal Contacts

0



Root Angulation

2



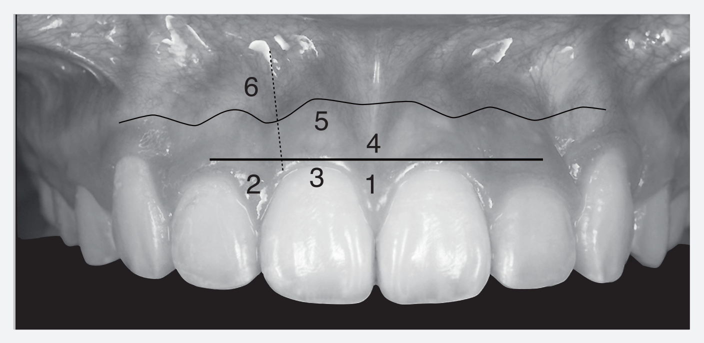
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 3

1. Pink Esthetic Score

Total = 2

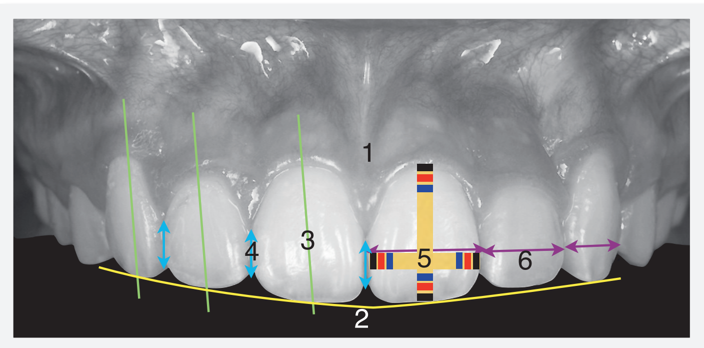


1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

1. M & D 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 = 1



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

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

IBOI Pink & White Esthetic Score for Implant Restoration

1. Pink Esthetic Score

Total = 1

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

2. White Esthetic Score (for Micro-esthetics)

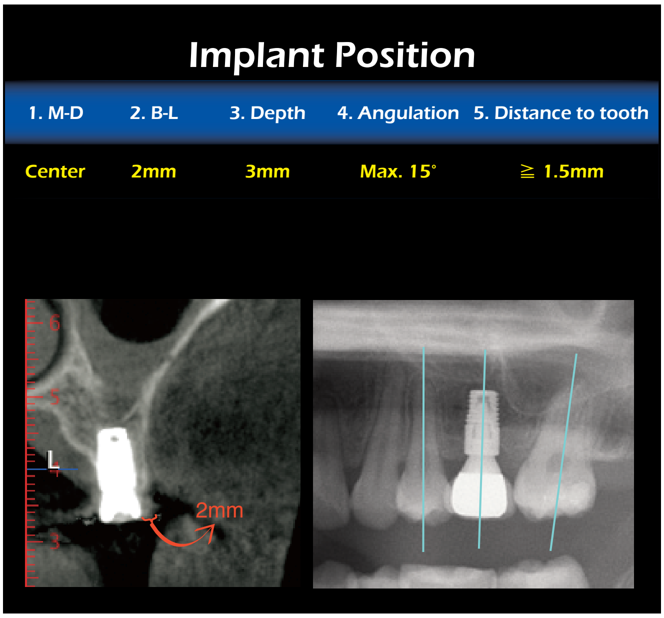
Total = 0

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

Implant-Abutment Transition & Position Analysis

3. Implant Position

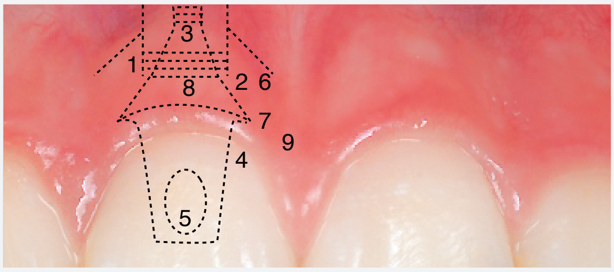
Total = 0



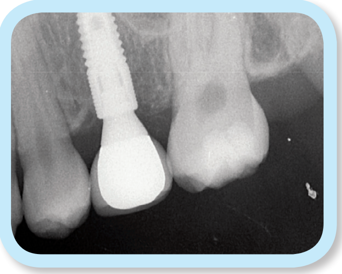
1. M & D (Center)	0	1	2
2. B & L (Buccal 2 mm)	0	1	2
3. Depth (3 mm)	0	1	2
4. Angulation (Max. 15°)	0	1	2
5. Distance to Adjacent Anatomy	0	1	2

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

2. Abutment transition Contour



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



Total = 1

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