Asymmetric Crowded Class II with Missing First Molars: Space Closure or Implants?

Abstract

A 30-year-old female presented with a Class II malocclusion complicated with severe maxillary anterior crowding, moderate deep-bite and the asymmetric loss of two permanent first molars: lower right (#30) and upper left (#14). The adjacent second molars were rotated and tipped mesially. A third molar was present on the lower right side (#32), but the third molar was missing from the upper left quadrant (#16). The Discrepancy Index (DI) for this asymmetric malocclusion was 16 points. Orthodontics treatment with a full fixed, passive self-ligating (PSL) appliance resulted in closure of the lower right space (area #30), but the missing third molar (#16) required opening space for an implant to replace the missing #14. After aligning the dentition, closing all mandibular space, and opening the implant site, cone-beam computer tomography (CBCT) imaging was utilized to evaluate bone distribution. A titanium fixture was installed in the palatal aspect of the #14 area, with a flapless surgical procedure. Thirteen months after fixture placement, orthodontic treatment was completed and an implant-supported prosthesis was delivered. The overall duration for the entire interdisciplinary treatment was 29 months. Multiple outcome assessment scores documented an excellent result: cast-radiograph evaluation (CRE) 22, dental esthetics 3, implant position 0, and abutment transition 1. (Int J Orthod Implantol;40:18-41)

Key words:

Class II canine relationship, missing first molars, molar-incisor hypomineralization, space management, crowding, deep bite, implant-supported prosthesis, flapless implant surgery

History and Etiology

A 30-year-old female with a partially edentulous malocclusion was referred by her general dentist for orthodontics consultation. The chief complaint was a lack of space for an upper left posterior prosthesis (*Figs. 1-3*). There was no contributory medical history, but the dental evidence was consistent with the early loss of permanent first molars due to molar-incisor hypomineralization (*MIH*).[1] Following 29 months of treatment, the patient was treated to an optimal result as documented in Figs. 4-6. The pre-treatment and post-treatment cephalometric and panoramic radiographs are shown in Figs. 7 & 8, respectively. Careful examination of the pretreatment radiographs revealed a morphologic asymmetry of the condyle heads and mandibular plane (*Fig. 7*), which apparently contributed to a cant in the occlusal plane and asymmetric facial form in the frontal view (*Fig. 1*). Superimposed cephalometric tracings document the dentofacial changes during treatment (*Fig. 9*).

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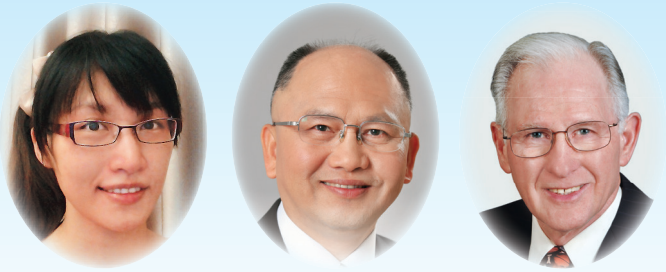

■ *Fig. 1: Pre-treatment facial photographs*

■ *Fig. 4: Post-treatment facial photographs*

■ *Fig. 2: Pre-treatment intraoral photographs*

■ *Fig. 5: Post-treatment intraoral photographs*

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

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

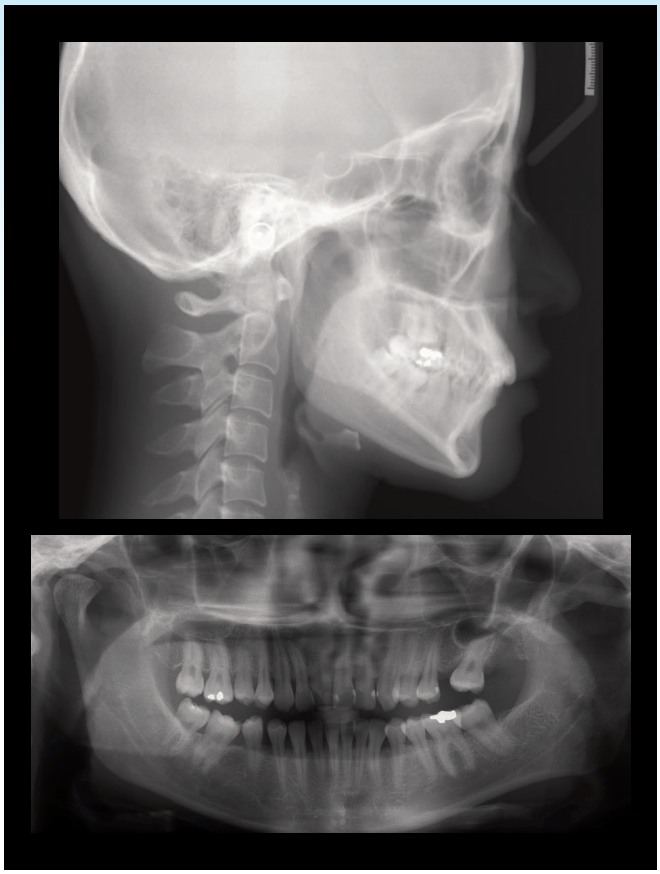

Fig. 7:
Pre-treatment lateral cephalometric and panoramic radiographs reveal high mandibular plane, asymmetric superiorly positioned right condylar head, and missing teeth (#14 & 30). Note the root length of #29 was shorter than other teeth.

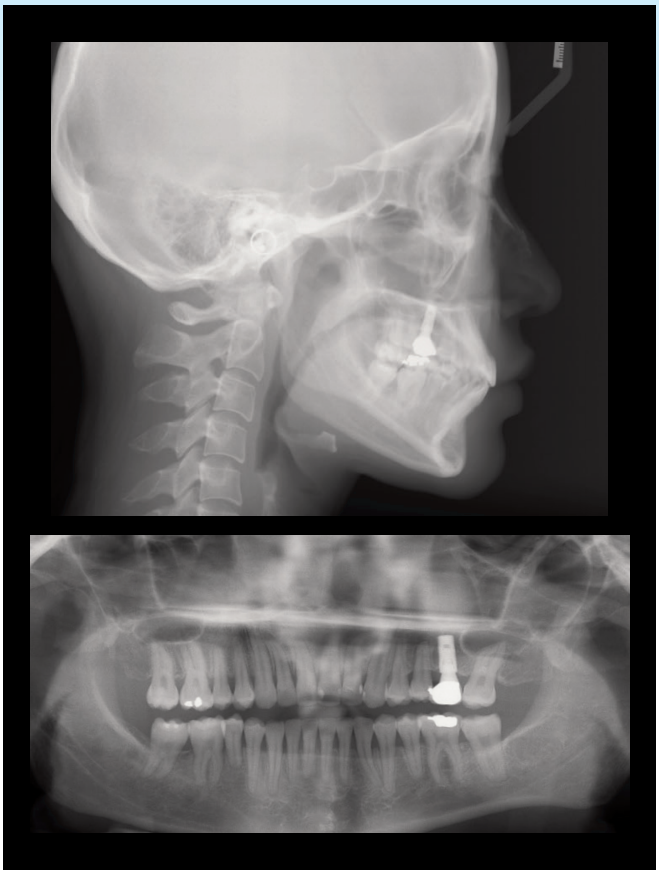

Fig. 8:
Post-treatment lateral cephalometric and panoramic radiographs reveal acceptable root angulations and the position of implant-supported prosthesis. The root length of #29 is shorter than it was pre-treatment.

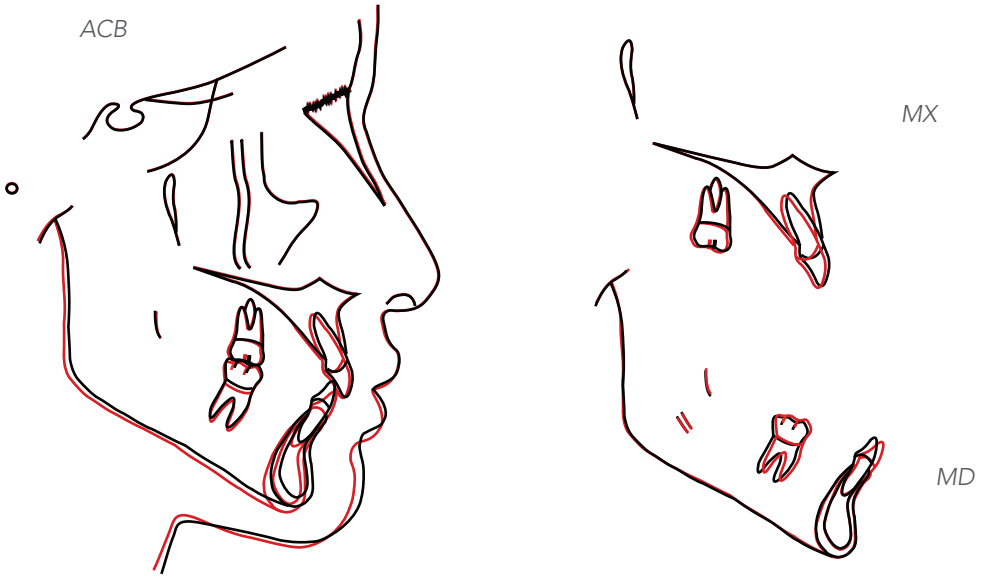

Fig. 9:
Cephalometric tracings before (black) and after (red) treatment were superimposed on the anterior cranial base (ACB), maxilla (MX) and mandible (MD).

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	80°	80°	0°
SNB°	77°	76°	0°
ANB°	3°	4°	1°
SN-MP°	38°	40°	2°
FMA°	31°	33°	2°
DENTAL ANALYSIS			
U1 TO NA mm	4 mm	3 mm	1 mm
U1 TO SN°	102°	104°	2°
L1 TO NB mm	4 mm	6 mm	2 mm
L1 TO MP°	87°	94°	7°
FACIAL ANALYSIS			
E-LINE UL	-2 mm	-2 mm	0 mm
E-LINE LL	-1 mm	0 mm	1 mm

Table 1: Cephalometric summary

Fig. 10:
Pre-treatment photographs document upper and lower anterior crowding, which increases the possibility for interproximal back triangles after leveling and alignment.

Diagnosis

Skeletal:

- Class I (*SNA 80°, SNB 77°, ANB 3°*)
- High, asymmetric mandibular plane angle (*SN-MP 38°*), with an enlarged and superiorly positioned right condyle

Dental:

- Angle Classification: *Class II canine with asymmetric molar interdigitation due to the loss of #14 and 30*
- Incisal relationships: *overjet 2mm, overbite ~5mm (Fig. 10)*
- Tooth Size to Arch Length Discrepancy: *crowding >7mm in the upper anterior, moderate crowding in the lower arch*
- Missing teeth were the upper left first molar (*#14*) and lower right first molar (*#30*)

Radiographic \ Panoramic:

- Short root on the lower right second premolar (*Fig. 7*)
- Asymmetric shape and size of condylar head: *right side is larger and more superiorly positioned*

Facial:

- Acceptable profile, modest cheek asymmetry in the frontal plane

The Discrepancy Index (*DI*) was 16 as shown in the subsequent worksheet.[2]

Specific Objectives of Treatment

Maxilla:

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

Mandible:

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

Maxillary Dentition:

- A - P: *Align and open space for an implant-supported prosthesis (ISP) in the area of #14*
- Vertical: *Maintain*
- Inter-molar Width: *Maintain*
- Inter-canine Width : *Maintain*
- Buccolingual Inclination: *Maintain*

Mandibular Dentition:

- A - P: *Align and close all spaces*
- Vertical: *Maintain*
- Inter-molar Width: *Maintain*
- Inter-canine Width: *Maintain*
- Buccolingual Inclination: *Maintain*

Facial Esthetics: Maintain

Treatment Plan

Non-extraction treatment with a passive self-ligating (*PSL*) bracket system was indicated.[2, 3] Align the dentition in a Class I occlusion and close all spaces, except for the upper left quadrant, where the edentulous site will be opened for an ISP in area of #14. Maintain facial form in the frontal and sagittal planes. Use intermaxillary elastics as needed to achieve a Class I interdigitation. At the end of active treatment, deliver clear overlay retainers for both arches.

Appliances and Treatment Progress

The .022" slot Damon Q® bracket system (*Ormco, Glendora, CA*) was used. The maxillary arch was bonded initially with the PSL appliance, using low torque brackets on the maxillary incisors (*Fig. 11*). The archwire (*.014" CuNiTi*) was engaged in all brackets and tubes except for the left second molar (*#15*),

Fig. 11

Low torque brackets were bonded on the upper incisors. The initial .014" CuNiTi archwire terminated at the left upper second premolar (yellow oval) and was not engaged in the tube of tooth #15 because it was likely to be displaced when chewing.

which was avoided because the wire was likely to be displaced during normal mastication. After one month of active treatment, the mandibular arch was bonded with standard torque PSL brackets and fitted with an .014" CuNiTi archwire. Bite turbos were placed on both upper central incisors to open the deep bite (*Fig. 12*). In the 5th month of active treatment, the upper archwire was changed to .018" CuNiTi and engaged in all brackets. An open coil spring was placed between #13 and 15 to create space for an ISP. Note the left side of the upper archwire extended to prevent disengagement with mastication. Drop-in hooks were fitted in the vertical slot of the upper first premolars, and the patient was instructed to wear Class II elastics (*Parrot 5/16, 2oz.*) bilaterally full time. The elastics extended from the upper first premolars to the most mesial lower molar to correct the sagittal discrepancy (*Fig. 13*).

Three months later, a rectangular .014x.025" CuNiTi wire was placed in the upper arch and the .018" CuNiTi was fitted in the lower arch. In the 9th month of treatment, interproximal enamel reduction was performed on upper incisors to eliminate the black triangles, and an elastomeric tube was applied

Fig. 12:
Standard torque brackets were bonded on the lower arch and a .014" CuNiTi archwire was fitted. Bite turbos (yellow marker) were placed on the palatal surface of the the upper central incisors to correct the deep bite.

Fig. 13-a:
The upper archwire was changed to .018" CuNiTi and engaged to all brackets. An open coil spring was placed between #13 and #15 (yellow marker) to create space for implant-supported prosthesis.

Fig. 13-b:
Class II elastics (Parrot 5/16, 2oz.) were applied bilaterally, from the upper first premolars to the lower molars (Left: 1st molar; Right: 2nd molar).

to close the space (*Fig. 14*). One month later, a progress panoramic film was used to evaluate axial inclinations (*Fig. 15*). The brackets for teeth #3, 5, 6, 11, 20, and 24 were repositioned. Twelve months into treatment, the upper archwire was replaced by .017x.025" low friction TMA, and the anterior segment was ligated with a .012" stainless steel (SS) ligature in a figure-eight pattern.

In the 14th month of active treatment, .016x.025" SS archwires were used for both arches. Lingual buttons were bonded on lower right first premolar and third molar. Elastomeric chains were then attached from first premolar to third molar, on both buccal and lingual surfaces, to close the residual edentulous space in the mandibular arch. Lingual force facilitates the process of space

Fig. 14:
To correct black triangles, interproximal enamel reduction was performed on upper incisors to create space that was closed with elastomeric tube.

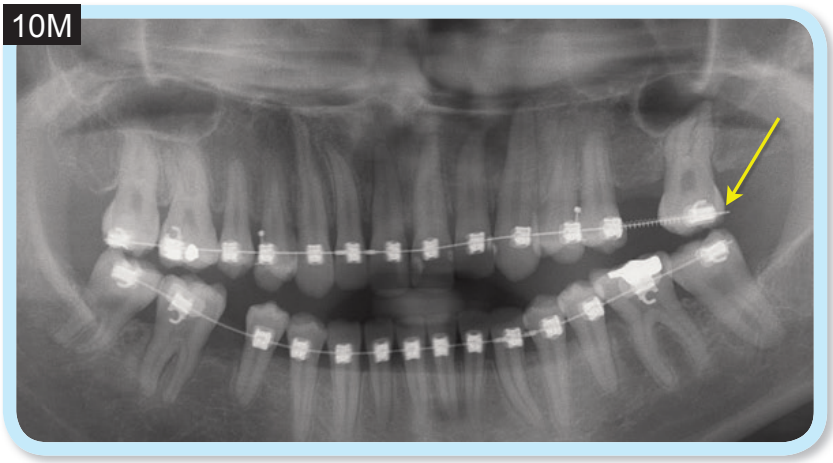

Fig. 15:
A progress panoramic film to assess axial inclinations shows that the archwire extended beyond the tube on the upper left side (yellow arrow).

closure and prevents the lower third molar from rotating distal-out (*Fig. 16-a*). The space for the implant site (*area #14*) was prepared by tipping the upper left second molar distally (*Fig. 16-b*).

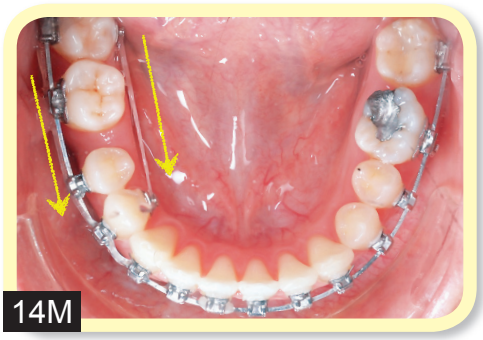

Fig. 16-a:
Elastomeric chains were attached on the buccal and lingual surfaces to achieve more efficient space closure (yellow arrows) and avoid iatrogenic rotation of the terminal right molar.

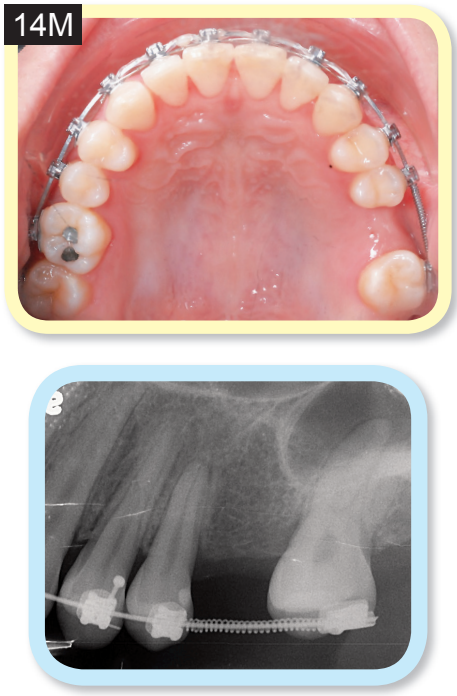

Fig. 16-b:
The implant site has been prepared in the area of tooth #14.

Implant Placement

Before surgery, a three-dimensional cone beam computed tomography (*CBCT*) image was utilized to evaluate bone density and volume in the implant site. Bone height of 11 mm and buccolingual width of 7 mm was adequate for a 4.3x10.0 mm implant. The anatomic structure of the implant site is shown in Fig. 17. Because of the abundance of soft and

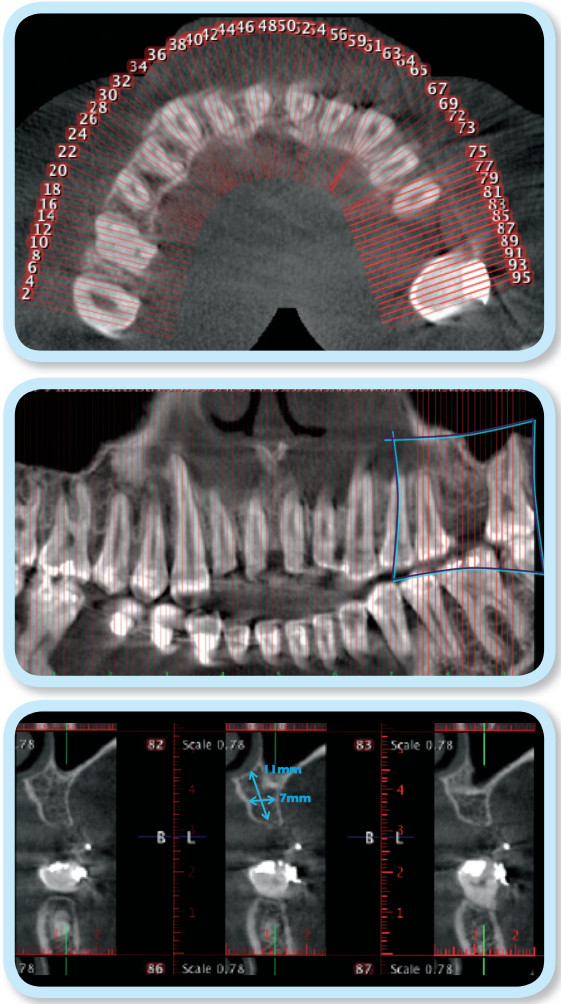

Fig. 17:
Slices of the CBCT scan demonstrate that the bone height was about 11 mm and bucco-lingual width was 7 mm.

hard tissue imaged on CBCT scan, a flapless implant surgery technique was indicated for the implant placement. A surgical stent was designed following the 2B-3D rule[4] for precise implant placement in all three dimensions (*Fig. 18*). To insure adequate bone of the buccal surface of the implant, the stent was designed for osteotomy penetration on the lingual aspect of the implant site (*Fig. 19*).

Under local anesthesia, the surgical stent was fitted into position and a periodontal probe marked the position of the future implant. A soft tissue punch

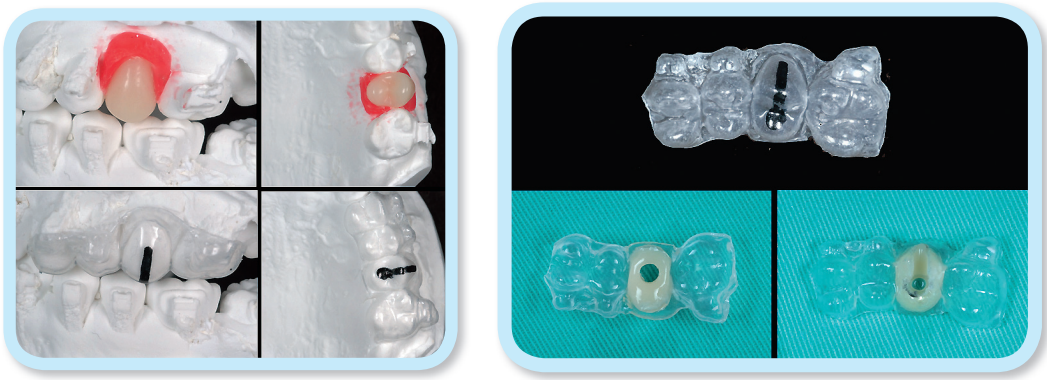

Fig. 18: A surgical stent was constructed according to the 2B-3D rule for precise implant placement in all three dimensions.

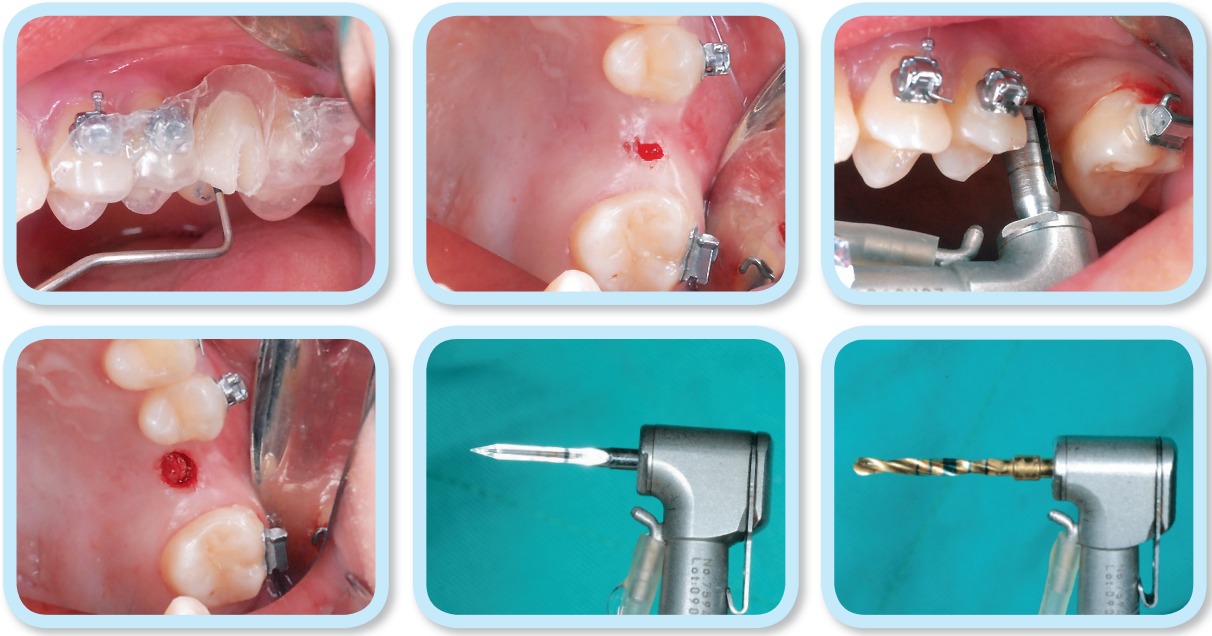

Fig. 19:
The surgical stent was fitted into position and a periodontal probe was used to penetrate the soft tissue to make a bleeding point to serve as a guide for implant position (upper center view). A gingival puncture (Ø4.0mm) was performed by a soft tissue trephine and the core of soft tissue was then detached from the crestal bone with a surgical curette (lower left view). The first lancer drill and the following twist drill are shown in the lower center and left views, respectively.

(*Ø4.0mm*) was utilized to make a circular incision through the gingiva (*Fig. 19*). The core of soft tissue was detached from the crestal bone with a surgical curette, and the soft tissue thickness was 2.5 mm, as measured with the periodontal probe.

The surgical stent was securely positioned for the initial osteotomy. The first lancer drill penetrated 10 mm in depth (*7 mm bone and 3 mm soft tissue*). Then the first twist drill was used to enlarge the osteotomy, at the depth established by the lancer drill. A surgical guide pin (*Ø2.0x10 mm*) was placed in the osteotomy, and a periapical radiograph was exposed to evaluate the distance between the sinus floor and the most proximal aspect of the implant site preparation. A periapical radiograph demonstrated that the angulation of surgical guide pin was not parallel to the long axis of the second premolar, so a side-cutting drill (*Linderman*) was used to correct the direction of the osteotomy (*Fig. 20*).

Once the orientation was corrected, the osteotomy was completed with twist drills, following the implant manufacturer recommendations. A 4.3x10.0 mm fixture was inserted (*Fig. 21*) with a rotary motion until the fixture depth was ~3 mm lower than the cervical margin of future prosthesis.[4] To complete the installation procedure, a 5 mm healing abutment was placed. Post-op radiographs showed that the angulation of the fixture was parallel to the long

Fig. 20:
A surgical guide pin (left) was placed and a periapical X-ray (center) was taken to check the position of the osteotomy. A side cutting Linderman drill (left) was used to correct the osteotomy orientation.

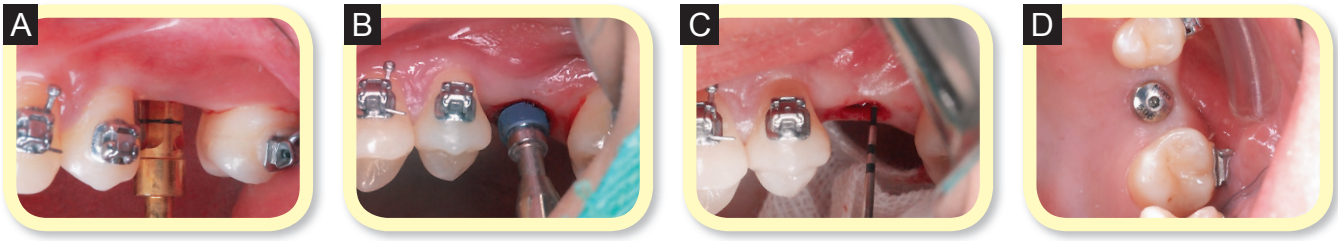

Fig. 21:
A 4.3x10.0 mm fixture (A) was installed (B). The fixture depth was 3 mm below the cervical margin of future prosthesis, measured with a periodontal probe (C). A 5 mm healing abutment was placed (D).

axis of second premolar, and was several mm away from the floor of the maxillary sinus. CBCT images confirmed that the buccal bone thickness was at least 2 mm, which is desirable for the longterm success of the implant-supported prosthesis (*Fig. 22*).

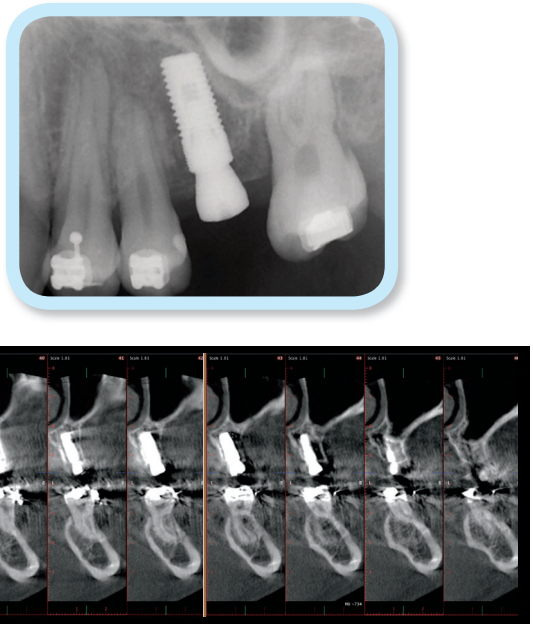

Fig. 22:
A post-operative periapical radiograph (left) and CBCT (right) were taken to check the position of the implant, as well as to confirm the integrity of the sinus membranes. The periapical view (left) showed the angulation of the fixture was parallel to the long axis of the second premolar, as planned. The slice view of the CBCT images (right) show that the buccal bone thickness was ≥2 mm.

Orthodontic Finishing Stage

Finishing with fixed appliances was accomplished during the post-op healing period before completion of the ISP.[5] To avoid rotating the second premolar with the compressed coil spring, a light-cured resin stop was installed on the archwire to serve as a stable base for applying the compressive force to the second molar (*Fig. 23*). In the 16th month

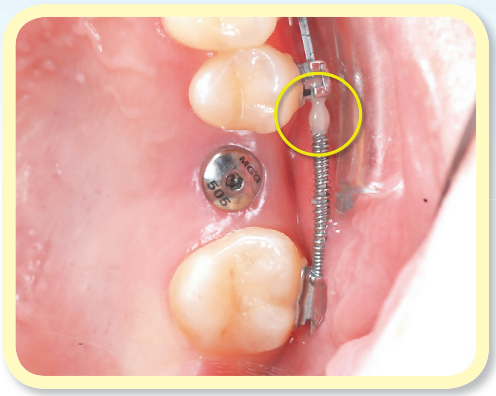

Fig. 23:
Light-cured resin (yellow circle) was used as a base on the archwire to produce a compressive load to tilt the second molar distally.

of active treatment, detailed finishing bends of the upper archwire were performed, and the patient was instructed to wear a rhomboid shaped elastic (*Fox 1/4, 3.5oz.*) on the right side to correct the localized Class II openbite relationship (*Fig. 24*).[6] At this point in treatment, the patient's availability for appointments was restricted by frequent trips abroad, and she could only return for treatment about every 6 months.

At 23 months of treatment, interproximal enamel reduction and space closure was performed between the upper central incisors to eliminate black triangles. L-type elastics (*Fox 1/4, 3.5oz.*) were applied from the upper canines to lower molars bilaterally (*Fig. 25*). Five months later, a progress panoramic film assessed root angulations (*Fig. 26*), and brackets were repositioned as needed. In the 29th month of active treatment, all fixed appliances were removed. Upper and lower clear overlay retainers were delivered for both arches.

Fig. 24:
At sixteen months into treatment (16), detailed finishing bends in the upper archwire were combined with a rhomboid shape elastic (Fox ¼", 3.5oz), as depicted by the yellow rhomboid figure on the right side.

Fig. 25-a: At 23 months, L-type elastics (Fox 1/4, 3.5oz.) were applied from the upper canines to lower molars bilaterally.

Fig. 25-b:
At 23 months, another interproximal enamel reduction was performed between the upper central incisors to complete the correction of the black triangle.

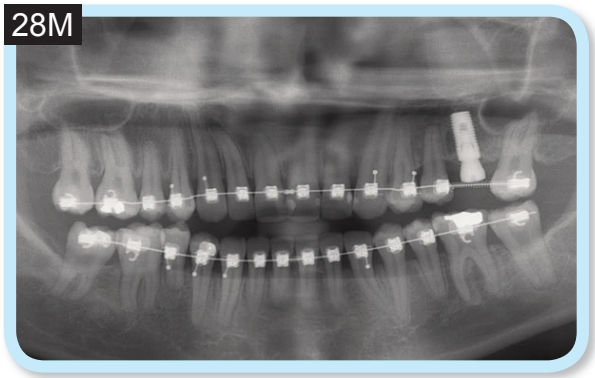

Fig. 26:
At 28 months, a progress panoramic film was taken to evaluate the root angulations.

Implant Prosthesis Fabrication

Thirteen months after the implant was placed, the healing abutment was removed, and the surrounding tissue thickness was found to be 3 mm. A 3.0 mm cuff height, multi-post abutment (*Ø5.0 mm, 5.2 mm post height and 3.0 mm cuff height*) was selected for prosthesis fabrication. The height of the abutment post was adjusted extraorally with a diamond bur, mounted on a high speed hand piece, to provide inter-occlusal clearance for fabrication of the porcelain fused to metal crown (*Fig. 27*). An abutment level impression technique was chosen. Before taking the impression, the abutment was torqued 25 N-cm with a torque wrench. A double core packing technique was used to retract the gingiva. The screw access hole for the abutment was then sealed with a small cotton pledget and temporary cement (*Fig. 28*). A direct impression was made with polyvinyl siloxane, and poured with type IV dental stone. The casts were subsequently articulated with check-bite records. After completion of the final prosthesis, its marginal integrity was verified with a dental explorer and appropriate tightness of the contact area was confirmed with dental floss.

Fig. 27:
A 3.0 mm soft tissue cuff height (left) indicated a 3 mm multi-post abutment (center). The post height was adjusted with a diamond bur mounted on a high speed head piece, to provide 2 mm inter-occlusal clearance for the fabrication of the porcelain fused to metal crown.

Fig. 28:
The height of the abutment was reduced to provide 2 mm of occlusal clearance (left). Double core packing technique was used to retract the gingiva (right).

After clinical adjustment and verification of the fit and occlusion, the definitive crown was luted into place with temporary cement, before the patient went abroad again. The screw access hole was filled with composite resin (*Fig. 29*).

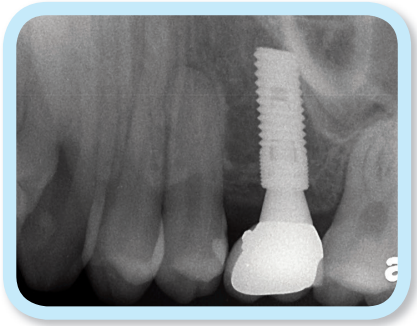

Fig. 29:
The final crown was luted into place with temporary cement. The crown contours and occlusal surface were coordinated with the adjacent second molar (a).

Results Achieved

Maxilla:

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

Mandible:

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

Maxillary Dentition:

- A - P: *Incisors were retracted slightly*
- Vertical: *Molars and incisors slightly extruded*
- Inter-molar Width: *Maintained*
- Inter-canine Width: *Maintained*

Mandibular Dentition:

- A - P: *Incisors moved anteriorly as their axial inclination was increased*
- Vertical: *Molars extruded and incisors intruded slightly*
- Inter-molar Width: *Maintained*
- Inter-canine Width: *Maintained*

Facial Esthetics:

- An acceptable profile with competent lips was maintained

Retention

The patient was instructed to wear the upper and lower clear overlay retainers full time for the first 6 months and nights only thereafter. Home care and retainer maintenance instructions were provided.

Final Evaluation of Treatment

The crowded, asymmetric malocclusion (*Figs. 2 and 3*) was corrected to Class I, but there was still a Class II tendency in the right buccal segment. The #30 edentulous space was closed and the #14 space was opened for an implant-supported prosthesis. Although the mandible was rotated posteriorly ~2mm, a pleasing profile with competent lips was achieved. The Cast-Radiograph Evaluation (*CRE*) score was 22 points.

The major discrepancies were alignment/rotation (*4 points*), marginal ridges (*4 points*), occlusal contacts (*6 points*), occlusal relationships (*5 points*), and root angulation (*3 points*). The following deviations from ideal were noted:

- The upper left second premolar and lower right lateral incisor were rotated mesial in, and the lower right second premolar was flared buccally.
- Marginal ridge discrepancies were noted in both the upper and lower buccal segments.
- Occlusal contacts were lacking for three buccal and two palatal cusps.
- The Class II occlusal relationship was not completely corrected on the right side.
- Root angulation problems were observed for the upper left second molar, lower left second premolar, and lower right third molar, that was moved into the second molar position.

A root resorption tendency (*Fig. 8*) was noted for the lower right second premolar (#*29*), a tooth that had a short root pre-treatment (*Fig. 7*). The patient was informed that this problem should be closely evaluated with long term follow-up. Despite a few minor alignment problems as noted in the CRE score, and a slight opening of the bite (*Fig. 10*), the interdisciplinary outcome for this complex, asymmetric malocclusion was very good.

Discussion

Increasing numbers of orthodontic patients are adults presenting with complex malocclusions, involving missing teeth, caries and/or periodontal disease. The treatment priority is to achieve optimal function and esthetics with a minimal prosthetics and treatment time. The present patient presented with a relatively common problem: acquired malocclusion secondary to the asymmetric loss of upper and lower first molars. The etiology for the isolated loss of first molars is often a hypomineralization defect that renders the newly erupted first molars highly susceptible to caries.[1] The problem may involve one or more of the permanent first molars and incisors, and the prevalence is >9% in children sampled all over the world. Incisor defects may be noticed by parents, but the first indiction of hypomineralized first molars is often the pain associated with an abscess. The "*bombed-out*" carious molars are usually untreatable and must be extracted, often only a year to two after eruption. The early loss of first permanent molars usually results in acquired malocclusions (*Fig. 7*). When second and third molars are retained in an affected quadrant, space closure may be the best option. If only one molar remains, an ISP may be the treatment choice (*Fig. 8*).

The treatment plan for the current patient was to create space for an upper left single implant-supported prosthesis and close the edentulous space in the lower arch. When creating space, an open coil spring is used to open the extraction site, and the archwire must be a little longer than normal to prevent it from being displaced by mastication (*Fig. 15*). The wire extending through the terminal molar tube may be an irritation, so a good option is to bond a bead of light-cured resin on the end of the wire.

When asymmetric spaces are closed, there may be problems with axial inclinations in the buccal segments. When closing large spaces, elastomeric chains on both the buccal and lingual surfaces considerably enhance the efficiency of space closure and helps avoid iatrogenic alignment problems. For instance, applying force only on the buccal surface usually results in distal-out rotation of the terminal molar in the anchorage unit. Another concern with space closure is excessive retraction of the incisors, resulting in a facial profile compromise. Torque control with incisor bracket selection and/or third order adjustment of archwires are important factors in achieving optimal outcomes.

The ABO Cast-Radiograph Evaluation (*CRE*) score was 22 points (*Fig. 30*). Although this is an excellent final score, some significant deficiencies were noted:

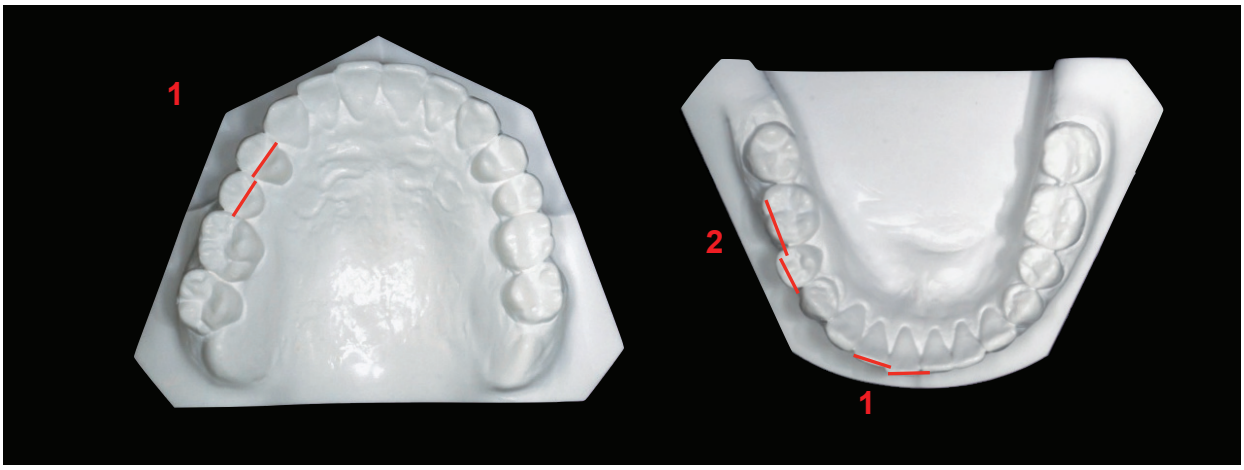

Fig. 30: The CRE: Alignment/Rotations were scored at 4 points as indicated by the red lines.

Fig. 31:
The bracket of tooth #4 was not properly positioned relative to the central axis of the tooth (yellow line).

Fig. 32:
First order (step) bends were used to correct the alignment of #25.

- **Alignment / rotation**: in the 23rd month of treatment a radiograph revealed that the bracket on tooth #4 failed to correct its rotation (*Fig. 31*), so it was repositioned. Also an archwire adjustment was needed to correct the alignment of tooth #25 (*Fig. 32*). Tooth #28 had an axial inclination discrepancy, that could be corrected with a cross elastic (*Chipmunk 1/8, 3.5oz.*) from a lingual button on tooth #5 to the bracket of tooth #28.

- **Marginal ridges**: marginal ridge discrepancies (*Fig. 33*) are best corrected by bracket repositioning and/or archwire adjustment (*detailing*) as shown in Fig. 34.

- **Occlusal contacts**: At the finishing stage, occlusal contacts are best optimized by sectioning the archwire distal to canines bilaterally, and then applying continuous vertical elastics to settle the occlusion.[7,8]

- **Occlusal relationships**: The right side class II occlusal relationship may have been a residual problem due to asymmetric size and shape of condyles (*Figs. 35-36*). Condylar morphology is consistent with a burned-out hyperplasia of the right mandibular condyle (*Fig. 7*). The best solution for the residual Class II problem was interproximal stripping of the lower incisors and then retracting them to create overjet; simultaneously, the buccal segment can be corrected with a unilateral Class II elastic. The latter must be applied judiciously to avoid a cant in the occlusal plane.

- **Root angulation**: Repositioning brackets is the best solution for root angulation and paralleling.

The lower right second premolar had a short root at the start of treatment (*Fig. 7*), and was even shorter after treatment (*Fig. 8*). This tooth was apparently

Fig. 33: The CRE Four marginal ridge discrepancies were scored 1 point each (red mark) for a total of 4 points.

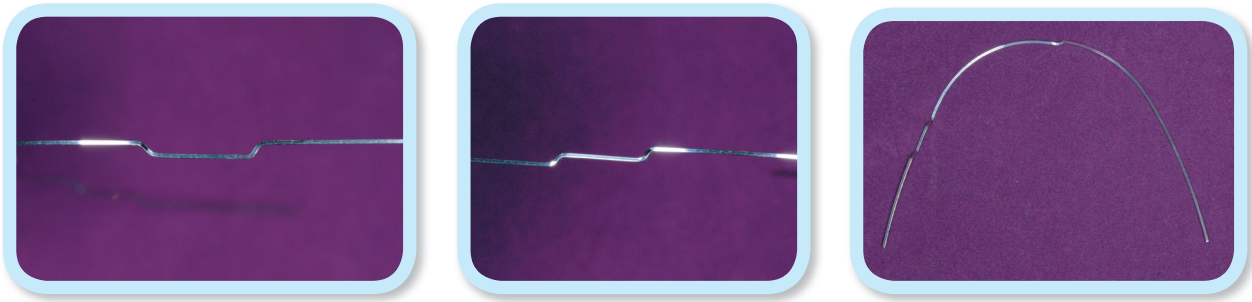

Fig. 34: Detailing bends

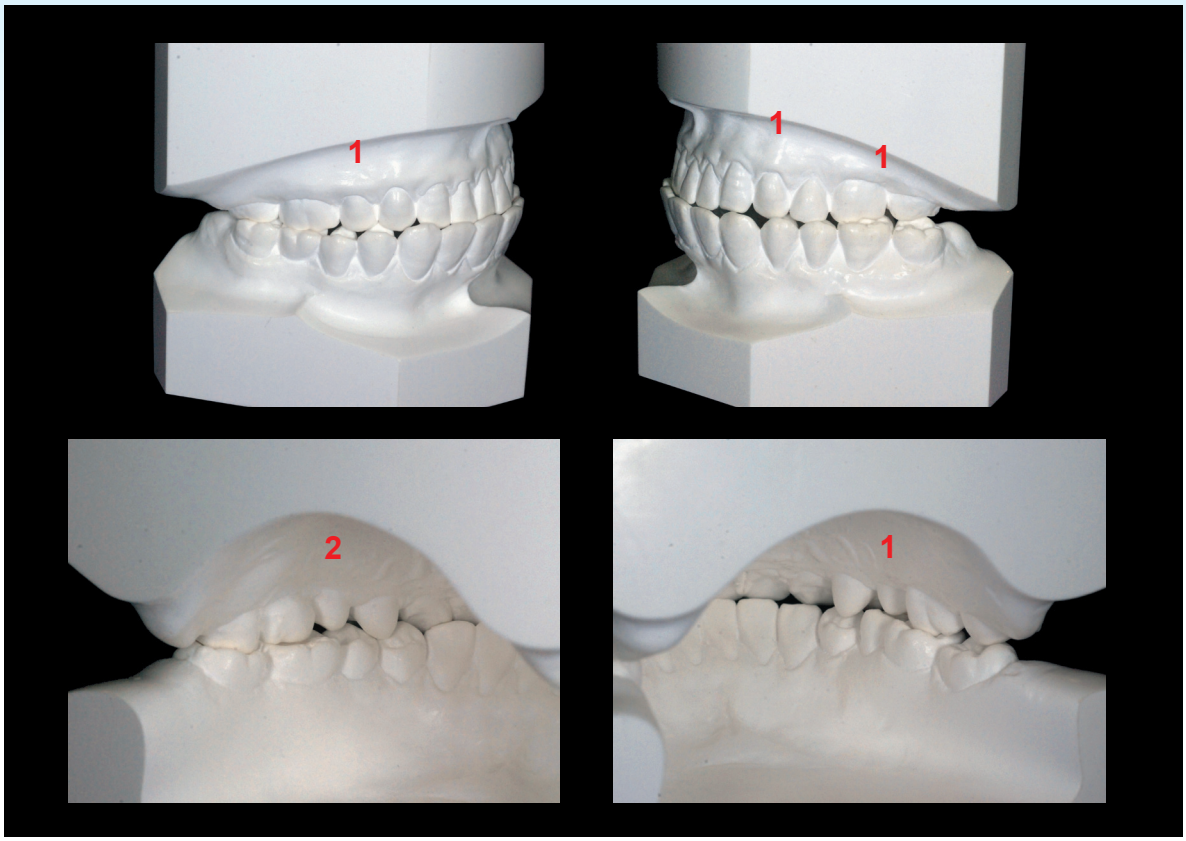

Fig. 35-a and b: The CRE Occlusal contacts was scored 1 or 2 points each (red marks) for a total of 6 points.

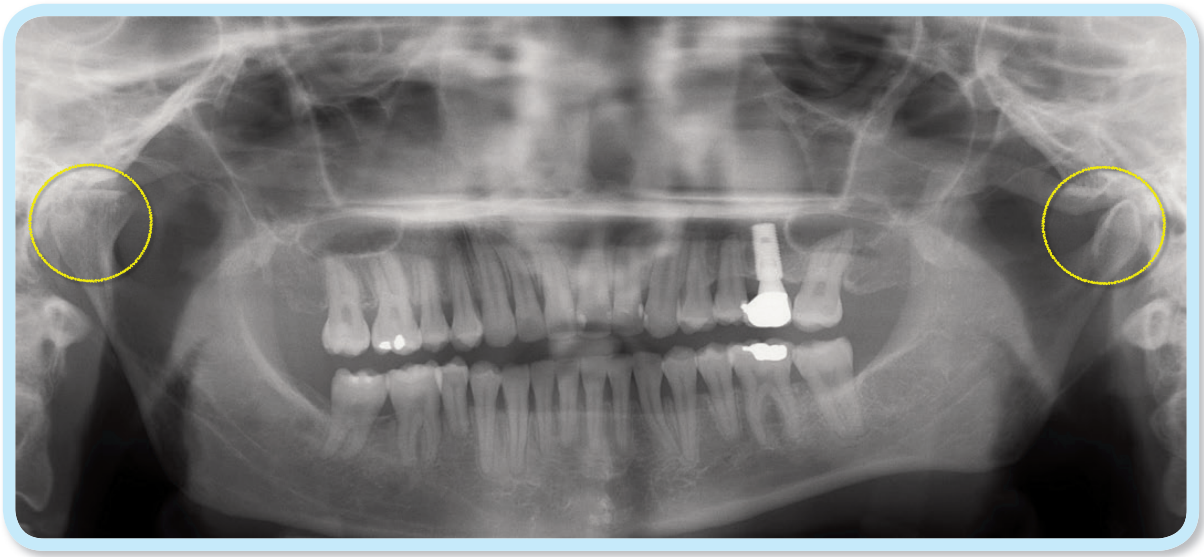

Fig. 35:
The CRE: Root angulation was scored 3 points. Note the asymmetric size and shape of condyles (yellow circles). The root resorption of #29 should be followed up long term.

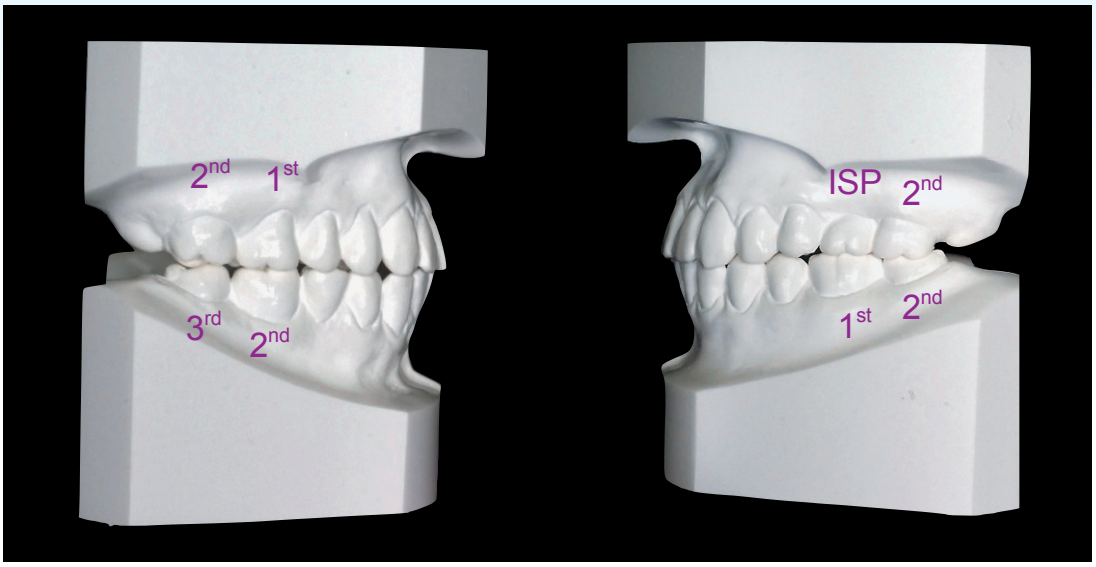

Fig. 36:
The CRE: Occlusal relationships was scored at 5 points because of the Class II interdigitation of all of the maxillary teeth in the right buccal segment. 1st, 2nd, 3rd *means ordinal number of molars; ISP means implant-supported prosthesis.*

predisposed to root resorption. Orthodontically induced inflammatory root resorption (*OIIRR*) is a serious sequela of orthodontic treatment. Evidence suggests that comprehensive orthodontic treatment increases the incidence and severity of root resorption.[9] Numerous investigators have attempted to elucidate factors contributing to and/or causing apical root resorption. The etiologic factors are complex and multifactorial, but the pattern that is emerging is a combination of individual biologic variability, genetic predisposition, and the effect of mechanical factors.[10, 11] Bite turbos may be helpful in controlling root resorption because they tend to decrease occlusal interferences.[12]

It is clear that cortical bone is more resistant to resorption, so it may slow tooth movement and/or result in more root resorption.[13] However, dense cortical bone may form within the alveolar process, and it is uncertain how they affect tooth movement. This situation may be encountered in an atrophic extraction site, particularly when a molar or premolar was lost at an early age. It may be difficult to close an atrophic extraction site, and the prevalence of root resorption could increase.[13] In this regard, the etiology of the progressive root resorption of tooth #29 may be cortical bone resistance when the tooth was rotated (*Fig. 8*).

Another factor in root resorption is individual biological variation. The root length before treatment was shorter than other comparable teeth, suggesting #29 was prone to root resorption. The rule of thumb indicates that it is better to inform early than to apologize later. In retrospect, the patient should have been informed about the risk of

root resorption prior to treatment. Progressive root resorption may result in an unfavorable crown-root ratio. Regular follow-up of a compromised tooth or teeth is indicated.

Conclusion

Adults may have crowded dentitions, despite multiple missing teeth. This scenario may present challenging asymmetric malocclusions, that are difficult to manage with cost-efficient, comprehensive treatment. Preprosthetic orthodontics to close space and optimize intermaxillary interdigitation is often a good option. Then residual edentulous spaces can be restored with single-tooth replacement, implant-supported prostheses.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 16

OVERJET

0 mm. (edge-to-edge)	=	
1 – 3 mm.	=	0 pts.
3.1 – 5 mm.	=	2 pts.
5.1 – 7 mm.	=	3 pts.
7.1 – 9 mm.	=	4 pts.
> 9 mm.	=	5 pts.

Negative OJ (x-bite) 1 pt. per mm. per tooth =

Total = 0

OVERBITE

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

Total = 2

ANTERIOR OPEN BITE

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

Total = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

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

Total = 7

OCCLUSION

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

Total = 2

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

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° = 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 = 2

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)	2 x 1 pts. =	2
Missing teeth, congenital	_____ x 2 pts. =	_____
Spacing (4 or more, per arch)	_____ x 2 pts. =	_____
Spacing (Mx cent. diastema ≥ 2mm)	@ 2 pts. =	_____
Tooth transposition	_____ x 2 pts. =	_____
Skeletal asymmetry (nonsurgical tx)	@ 3 pts. =	_____
Addl. treatment complexities	_____ x 2 pts. =	_____

Identify:

Total = 2

IMPLANT SITE

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

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

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

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

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

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

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

Total = 1

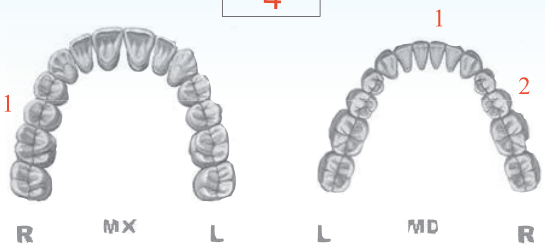
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 22

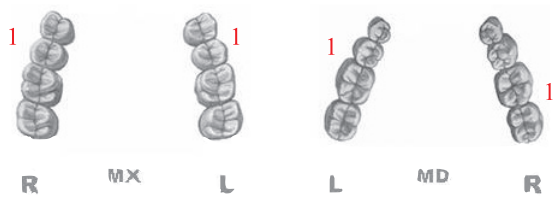
Alignment/Rotations

4



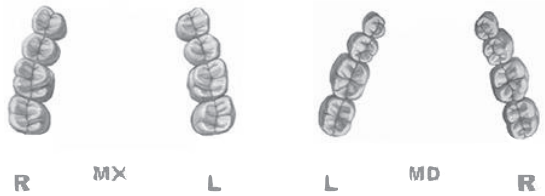
Marginal Ridges

4



Buccolingual Inclination

0

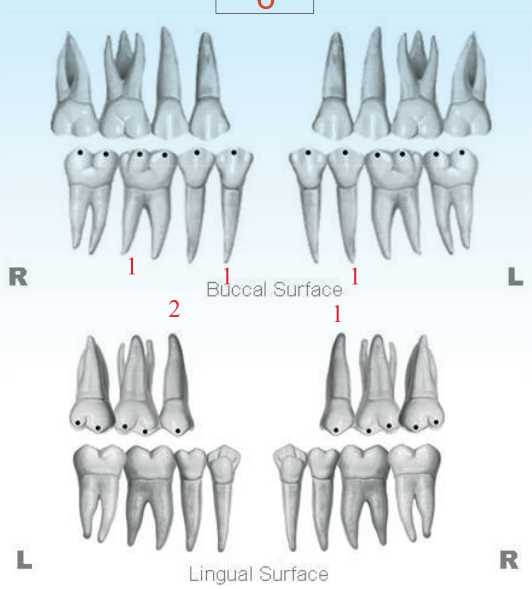


Overjet

0

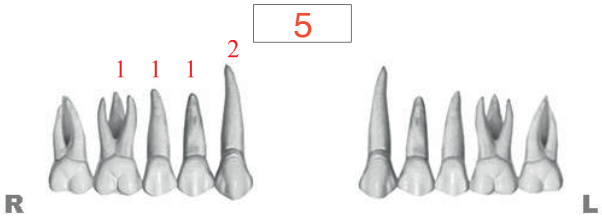
Occlusal Contacts

6



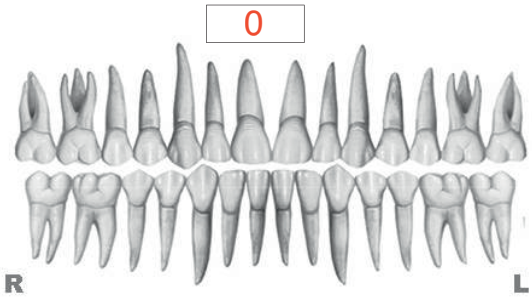
Occlusal Relationships

5



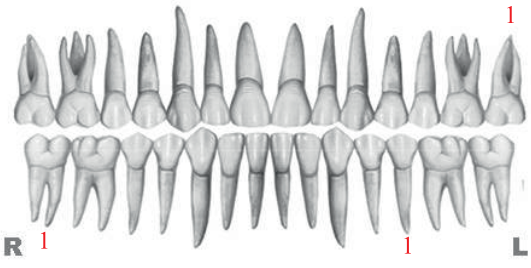
Interproximal Contacts

0



Root Angulation

3



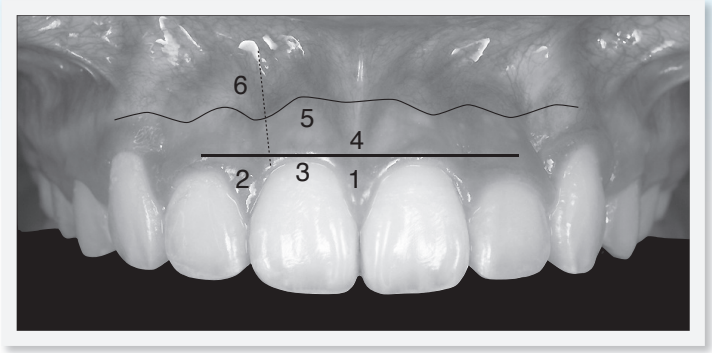
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 3

1. Pink Esthetic Score

Total = 1

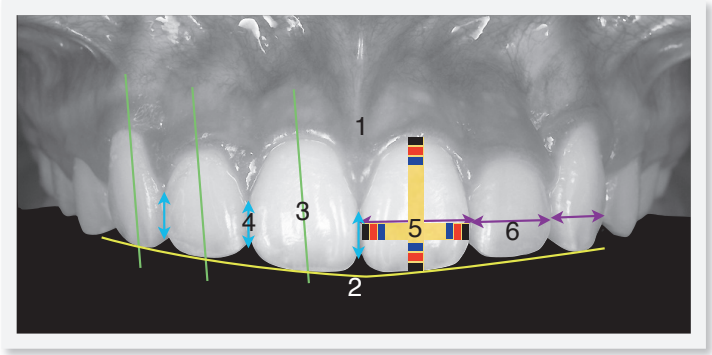


1. M & D Papilla	0	1	2
2. Distal Papilla	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

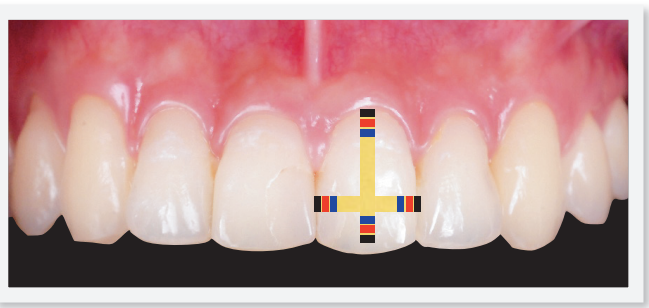
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	0	(1)	2
4. Level of Gingival Margin	(0)	1	2
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 2



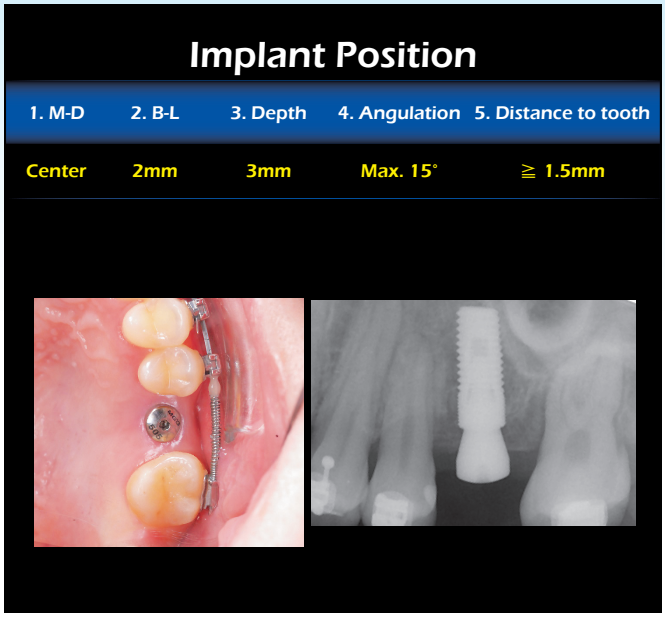
1. Midline	0	1	2
2. Incisor Curve	0	1	2
3. Axial Inclination (5°, 8°, 10°)	0	1	2
4. Contact Area (50%, 40%, 30%)	0	1	2
5. Tooth Proportion (1:0.8)	0	1	2
6. Tooth to Tooth Proportion	0	1	2



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

Implant-Abutment Transition & Position Analysis

3. Implant Position

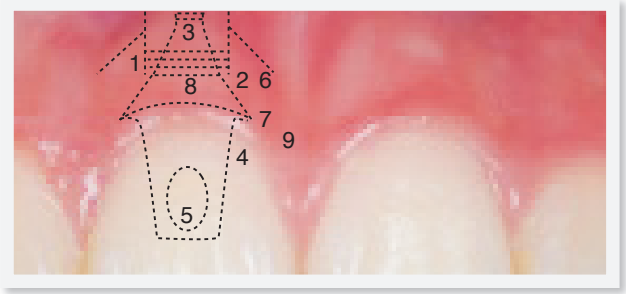


Total = 0

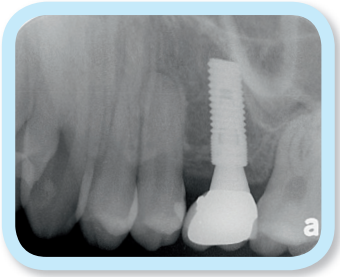
1. M & D (Center)	0	1	2
2. B & L (Buccal 2 mm)	0	1	2
3. Depth (3 mm)	0	1	2
4. Angulation (Max. 15°)	0	1	2
5. Distance to Adjacent Anatomy	0	1	2

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

4. 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