Orthodontics and Implant Treatment of a Class II Crowded, Partially Edentulous Malocclusion

SUMMARY

An adult female presented with a compensated Angle Class II malocclusion complicated by severe crowding, posterior crossbite and absence of five permanent teeth. An extended period of dental neglect resulted in a severe asymmetric malocclusion with major discrepancies in the vertical, transverse, and anterior-posterior dimensions. A self-ligating appliance with bite turbos and bone screw anchorage achieved a preprosthetic alignment consistent with the patient's desire for normal function and pleasing esthetics. However, a bite turbo on the maxillary left lateral incisor was associated with pulp necrosis, internal resorption and an unrestorable tooth fracture during orthodontics treatment. The fractured tooth was temporarily restored by bonding its fractured crown to the adjacent teeth. Cone bean CT images were taken, and one month later the fractured incisor was gently extracted. An implant was placed with a surgical stent via a flapless approach, and Platelet Rich Fibrin (PRF) was used to fill the apical fistulous tract and the gap between the fixture and the alveolar crest of bone. An immediate provisional restoration was used to restore optimal esthetics and function, as well as to serve as a guide for optimal healing of soft and hard tissue. (IJOI 2014;34:30-55)

Key word: *Angle Class II malocclusion, deep bite, posterior crossbite, multiple missing teeth, self-ligating appliance, bite turbo, internal root resorption, fatigue fracture, bone screw anchorage, atraumatic extraction, immediate implant placement, surgical stent, Platelet Rich Fibrin (PRF), immediate provisional restoration.*

History and Etiology

A 27-year-and-10-month-old female desired comprehensive treatment for a complex malocclusion (*Figs. 1-3*). Her chief complaints were an unesthetic dentition and functional problems when chewing. There were no known harmful habits which might have contributed to the malocclusion. The initial clinical exam revealed a complex malocclusion that was compromised by a long period of dental neglect. The patient preferred an interdisciplinary treatment plan to align and restore her teeth with a minimum of implants, prosthetics and treatment

Fig. 1: Pretreatment facial photographs

Fig. 2: Pretreatment intraoral photographs

Fig. 3: Pretreatment study models

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Fig. 4: Progress facial photographs

Fig. 5: Progress intraoral photographs

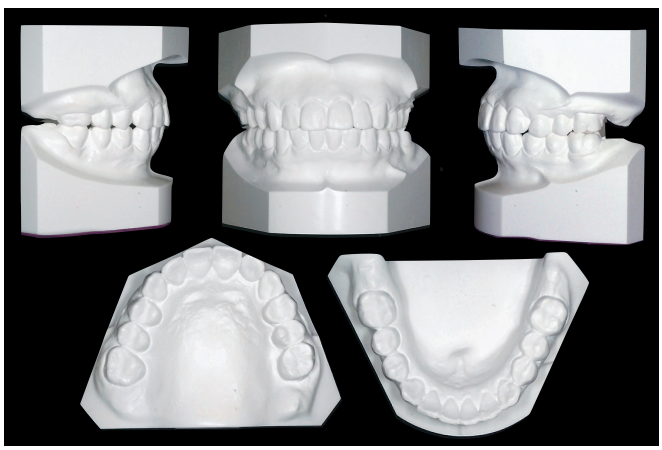


Fig. 6: Progress study models

time. She was treated to an acceptable result as documented in Figs. 4-6. Cephalometric and panoramic radiographs document the complexity of the malocclusion (*Fig. 7*), as well as the post-treatment results (*Fig. 8*). Note that the patient is not in occlusion when the panoramic radiographs were exposed to provide a better view of the crowns for all teeth. Superimposed cephalometric tracings reveal the treatment achieved (*Fig. 9*).

Diagnosis

Bilateral class II buccal segments were complicated by: 1. missing first and second molars (#*30 & 31*) in the lower right quadrant, 2. residual roots for the upper right first molar (#*3*) and upper left second molar (#*14*), 3. multiple compromised restorations, and 4. active caries (*Figs. 2-3*). Orthodontics evaluation revealed a 6.5mm overjet, 4mm overbite, and anterior crowding was noted in both arches. Fig. 10 is a differential display of the anterior crowding, irregular dental alignment, and compromised gingival display in both anterior segments. The right posterior crossbite is more clearly visualized in a pharyngeal (*back*) view of the right segments of the pretreatment casts (*Fig. 11*). The upper right second molar (#*2*) was extruded and contacting the opposing edentulous ridge. Preprosthetic

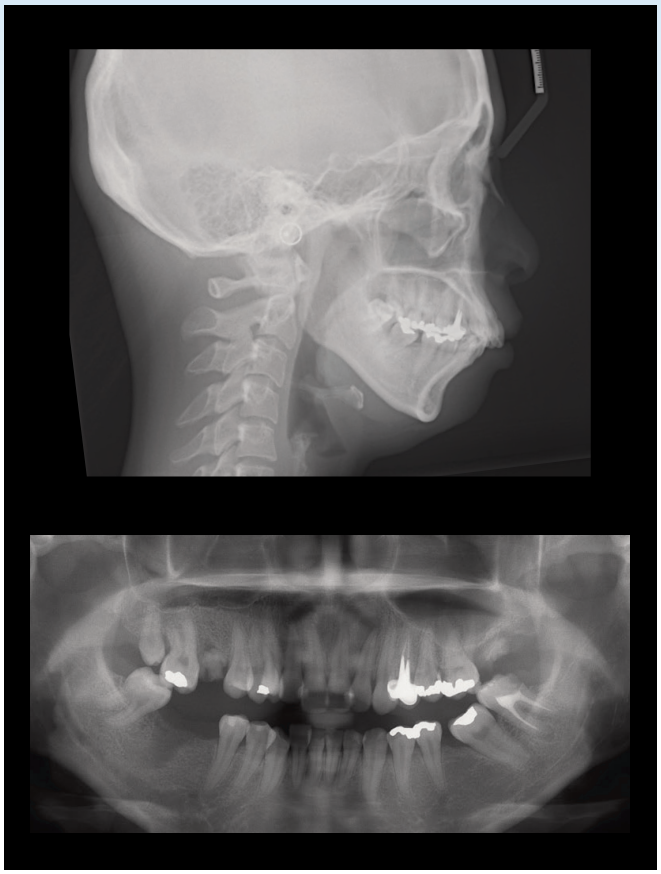


Fig. 7:
Pretreatment panoramic and cephalometric radiographs

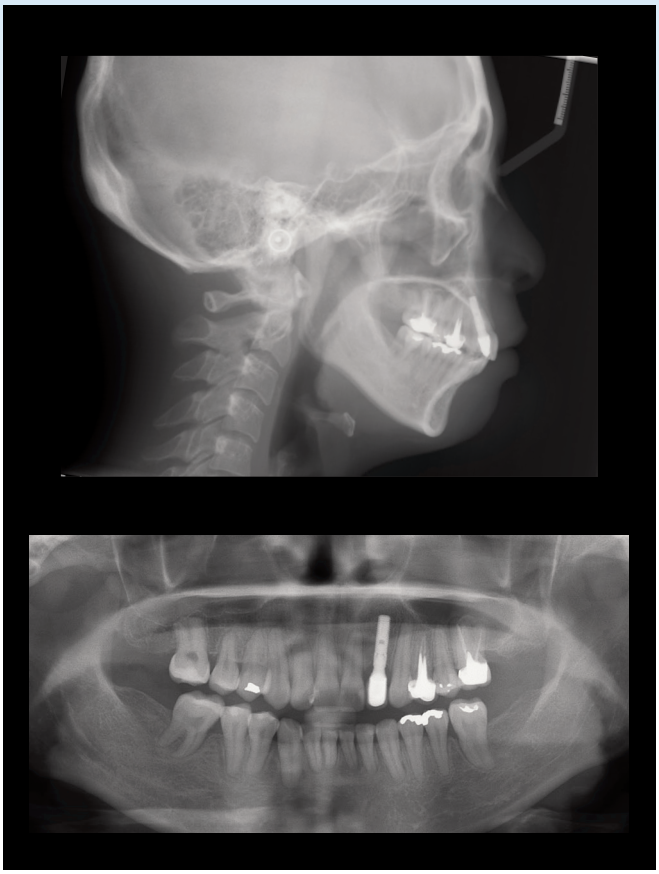


Fig. 8:
Post-treatment panoramic and cephalometric radiographs

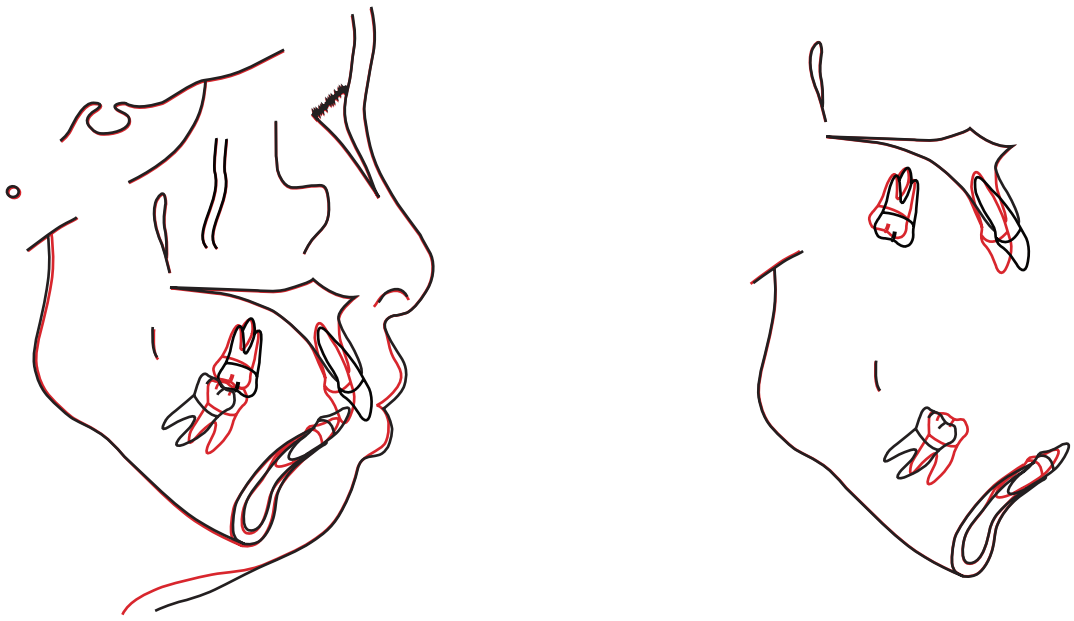


Fig. 9:
Superimposed tracings show retraction of the maxillary incisors and the intrusion of the lower incisors. Maxillary molars were retracted and slightly intruded. Mandibular molars were uprighted and moved mesially. Lip protrusion was reduced to improve the facial profile.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA°	80°	80°	0°
SNB°	73°	73°	0°
ANB°	7°	7°	0°
SN-MP°	45.5°	46°	0.5°
FMA°	38°	38.5°	0.5°
DENTAL ANALYSIS			
U1 TO NA mm	8 mm	2 mm	6 mm
U1 TO SN°	109°	98°	11°
L1 TO NB mm	12.5 mm	8 mm	4.5 mm
L1 TO MP°	102°	102°	0°
FACIAL ANALYSIS			
E-LINE UL	3.5 mm	1.5 mm	2 mm
E-LINE LL	5 mm	3 mm	2 mm

Table 1: Cephalometric summary

orthodontics was essential for restoring this patient to optimal esthetics and function, in a cost-effective manner.

Angle Classification:

- Bilateral Class II molar relationship
- Full cusp discrepancy bilaterally is simulated in Fig. 12 for this complex, acquired malocclusion.

Tooth Size Arch Length Discrepancy:

- Maxillary: 9mm of crowding
- Mandibular: 2mm of crowding

Transverse Problems:

- Buccal crossbite of upper right 2nd molar (#2)
- Lower midline discrepancy was 1.5mm to the right

Facial: Protrusive lips

Radiographic\Cephalometric:

- Skeletal: Class II (*SNA 80°, SNB 73°, ANB 7°*), high mandibular plane angle (*SN-MP 45.5°*)
- Dental: Increased axial inclination of the lower incisors (*IMPA 102°*)

Radiographic\Panoramic:

- Atrophic bony height in the posterior edentulous areas of the mandible
- A faint periapical radiolucency was noted mesial to the root of the upper left lateral incisor (#*10*), but the tooth was asymptomatic

Radiographic\Other:

- Asymmetric contours of the condylar heads were noted (*Fig. 13*)

ABO Discrepancy Index (*DI*)

- Score of 61 including 4 points added for implant site evaluation as shown in the subsequent worksheet.[1]

Specific Treatment Objectives

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

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

Maxillary Dentition

- A - P: Retract molars and incisors
- Vertical: Slight intrusion of molars and incisors

Fig. 10:

Adults with crowded incisors that have a tapered shape and irregular gingival contours are prone to loss of papilla height and interproximal black triangles when the teeth are aligned. This problem is best managed in during orthodontic finishing with enameloplasty: IPR (interproximal reduction) and recontouring of wore incisor edges.

Fig. 11:

The posterior (pharengeal) view of the casts shows the right posterior third molar is in full buccal crossbite.

Fig. 12:

Bilateral full-cusp, Class II relationships in both buccal segments of this partially edentulous malocclusion are clearly demonstrated with virtual first molars.

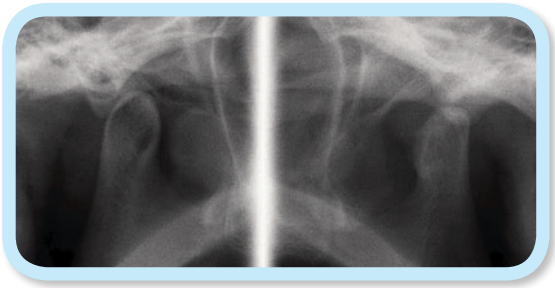


Fig. 13:

Asymmetric mandibular condylar heads were noted, but there were no signs or symptoms of temporomandibular disorder.

- Intermolar Width: Maintain
- Intercanine Width: Maintain
- Buccolingual Inclination: Maintain

Mandibular Dentition

- A - P: Mesial movement and uprighting of molars, slight retraction of incisors
- Vertical: Slightly extrude molars as they are uprighted and intrude incisors
- Inter-molar Width: Maintain
- Inter-canine Width: Maintain
- Buccolingual Inclination: Correct right 3rd molar axial inclination

Facial esthetics: Reduce lip protrusion

Treatment Plan

Minimizing the numbers of implants was an important orthodontics objectives. The first priority was to extract residual roots of the upper right first (#*3*) and upper left second (#*15*) molars, as well as the lower left third molar (#*17*). The patient was informed that a root canal therapy might be needed for the upper right lateral incisor (#*10*), because of the radiolucency (*Fig. 14*). Standard torque brackets

Fig. 14:

Although a possible periapical lesion is shown pre-treatment (left), the upper left lateral incisor (#10) was not symptomatic until six months later, shortly after a bite turbo had been applied. Note the small area of external root resorption in the distal cervical area of #10 prior to endodontic treatment.

were prescribed for both the upper and lower incisors. Bite turbos were needed in combination with cross elastics to correct the crossbite.[2] Freedom to upright the right lower third molar required intrusion of the upper second molar. Bone screws in the infrazygomatic crests were necessary to retract the protruded maxillary dentition. A third bone screw in the lower right buccal shelf was necessary to protract the lower right third molar. If the residual spaces, especially the 17mm on the lower right side, could be closed completely, the upper right 3rd molar (#1) could be extracted, and no posterior implants would be placed. Final occlusion was detailed with vertical elastic traction.[3] The corrected dentition would be retained with fixed retainers and clear retainers.

Appliances and Treatment Progress

After the residual roots of #3 & 15, as well as tooth #17, had been extracted, a .022" slot self-ligating appliance Damon Q bracket system (*Ormco*) was used. Standard torque brackets were bonded on

Fig. 15:

A bite turbo on the upper right lateral incisor is used to disarticulate the occlusion to expedite alignment of both arches. Occlusion on the bite turbo produces an intrusive force and a moment on the incisor that is directly proportional to the length of the lever arm.

both upper and lower incisors. The initial upper archwire was .014 CuNiTi was fitted with resin "*pearls*" that were bonded on the ends of the archwire to prevent mucosal irritation. Bite turbos were placed on teeth #7 & 11 (*Fig. 15*) to correct the crossbite of #7 & 32. Furthermore a lingual button was bonded on tooth #32 for to attach a criss-cross elastic (*Quail 3/16" 2oz*). In the 4th month of active treatment, the crowding was relieved and the crossbite of #7 was corrected. Then a upper .014"x.025" CuNiTi wire was engaged for root torque and axial inclination control. At the same appointment, the left anterior bite turbo was moved from the maxillary canine (#11) to the adjacent lateral incisor (#10). Two months later, the patient complained of pain, and the pulp of the upper left lateral incisor (#10) was found to be necrotic, so the patient was referred for root canal

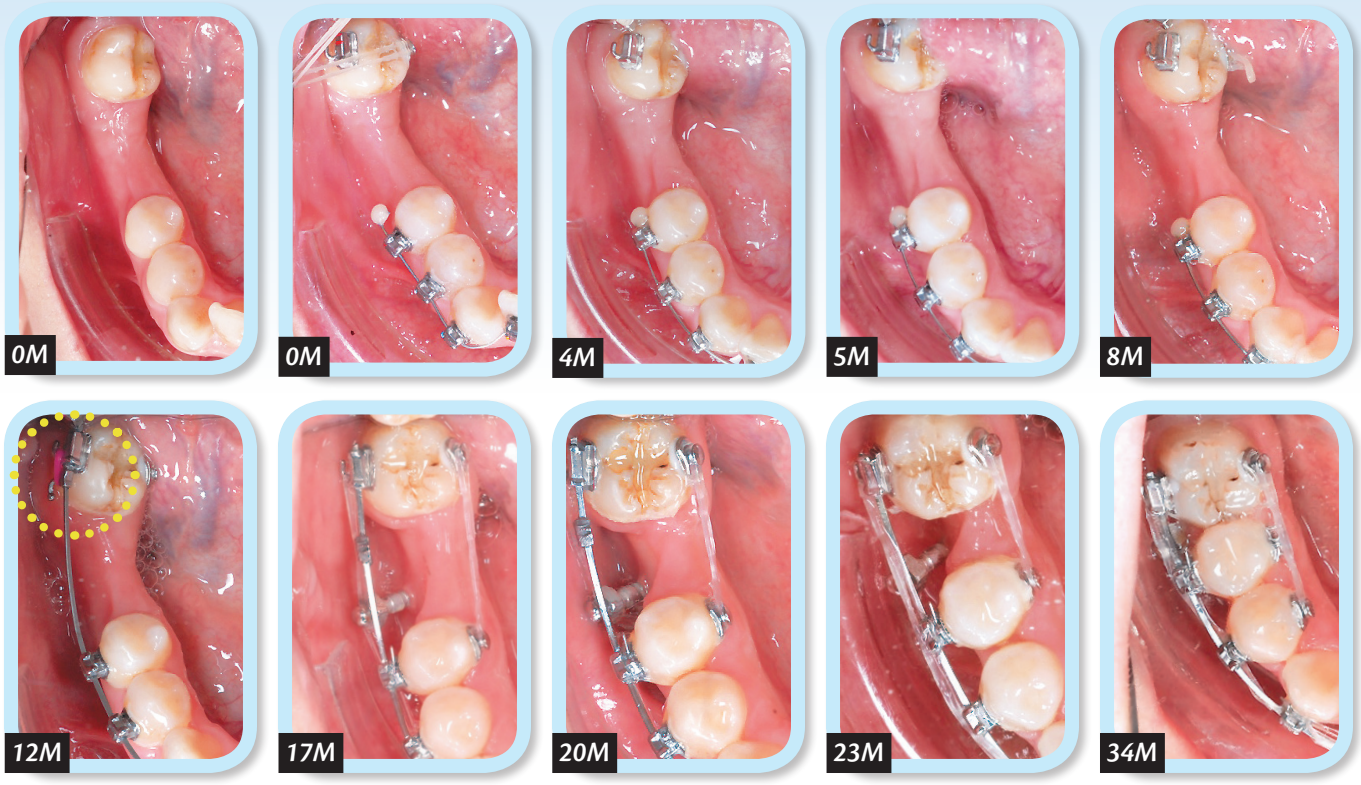


Fig. 16:

Progress photographs for the first 8 months of treatment (top four views) show little progress in uprighting the third molar (#32). Subsequent use of a rectangular archwire and a bone screw efficiently uprighted the molar. The bone screw was also used to protract the molar to close the edentulous space from 12-34 months.

therapy (*Fig. 14*). After 10 months of treatment, the criss-cross elastics had not corrected the lingual collapse of the lower right third molar (*Fig. 16*). A bone screw (*2x12mm OrthoBoneScrew, Newton's A Ltd.*) was placed in the lower right buccal shelf to upright #17. Two months later #17 was uprighted and in occlusion, so the bone screw was removed (*Fig. 17*). In the 11th month, a new upper .017"x.025" TMA arch wire was placed and the figure-eight ligature was tied to maintain firm contact of the six anterior teeth. In the 12th month, the bone screw in the buccal shelf was removed and a lower 014" x.025" CuNiTi wire was placed (*Fig. 18*). However the distance between teeth #29 & 32 was too large to maintain the archwire in the slot. A crimpable hook was placed on the archwire in front of #32, and an O-ring was used to secure the archwire to the tooth to prevent the tail of the wire from slipping out (*Fig. 16*). Bite turbos were placed on the upper second premolars to open the bite to allow #17 to be moved mesially into the plane of occlusion. Drop-in hooks were fitted in the vertical slot of the lower second premolars to secure class II elastics (*Parrot 5/16" 2oz*).

In the 15th month, a lower .016"x.025" stainless steel archwire was placed to accommodate the greater force for the class II elastics (*Fox 1/4" 3.5oz*). One month later, bone screws (*2x12mm OrthoBoneScrew, Newton's A Ltd.*) were inserted into the infrazygomatic crests bilaterally to retract the entire maxillary dentition, except for tooth #2. Another bone screw was placed buccal and distal to the lower right second premolar to protract the third molar with the power chains. The lower six anterior teeth were tied together with a figure-eight ligature. Drop-in hooks were fitted in the vertical slot of the upper canines for wearing Class II

Fig. 17:

A power chain from a lingual button bonded on the lower right third molar (#32) applied an intrusive and buccal force that uprighted the molar in 3 months.

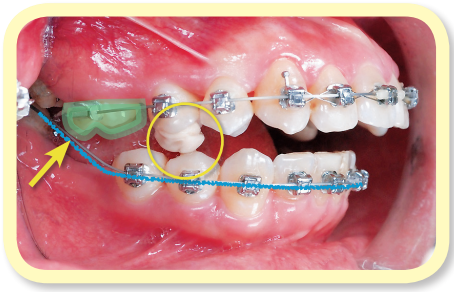


Fig. 18:

A bite turbo was added to the upper right 2nd premolar (#4) to provide clearance for the lower archwire (yellow arrow) to prevent it being dislodged from the tube on #32. The lower archwire was secured with a crimpable hook on the archwire that was connected to the buccal tube hook with an elastic O-ring, as shown for the 12th month of treatment in Fig. 16.

elastics, which were used continuously until the end of active treatment.

In the 30th month, black triangles were noted interproximally between the four upper incisors. After interproximal enamel reduction, an elastomeric chain was applied to close the space (*Fig. 19*).[4] Two months later, both bone screws on the right side were removed. A progress panoramic film showed that most of the residual spaces had been closed, so implants would not be needed (*Fig. 20*). However, unacceptable root inclinations of teeth #4, 5, 12 and 32 were managed by repositioning their brackets and realigning with the flexible .014"x.025" CuNiTi

Fig. 19:

After the crowding was relieved, the black triangles were corrected with IPR (interproximal reduction) and the space created was closed with power chains.

wires. During the bracket repositioning procedure for the upper left lateral incisor the coronal portion of the tooth fractured from its root (*Fig. 21*). It was clear that the tooth was hopeless and an implant was required to replace it. As a temporary measure, the coronal portion of the upper left lateral incisor

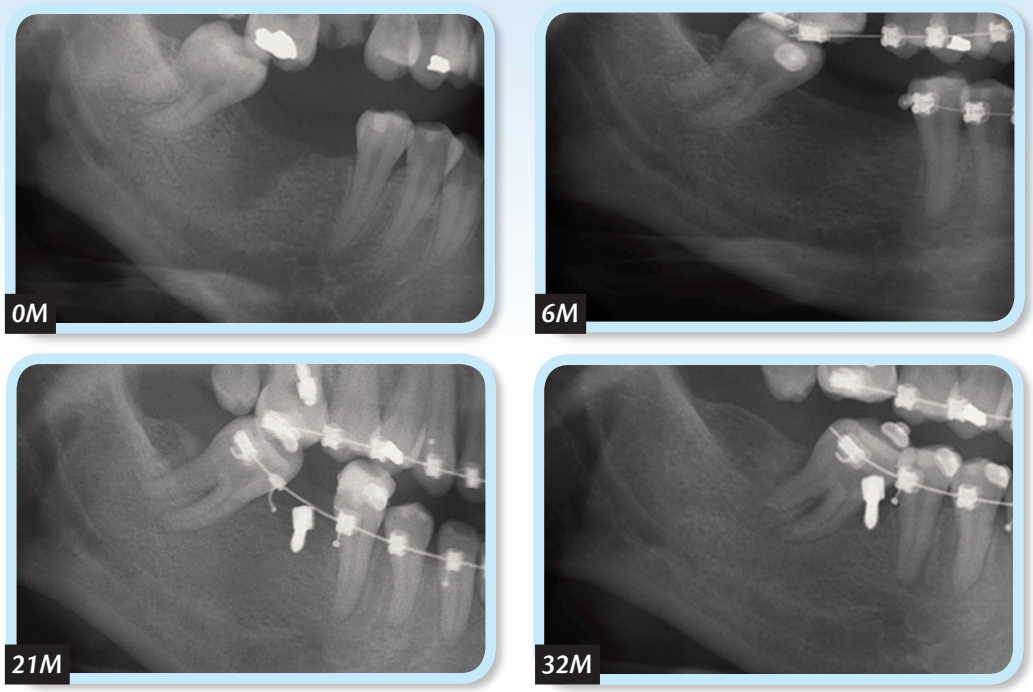


Fig. 20:

The buccal uprighting and 17mm mesial protraction of the lower right third molar is shown in a series of panoramic radiographs taken at 0, 6, 21 and 32 months of treatment. The mesial protraction of the molar was actually accomplished in about 22 months because the first 10 of treatment involved the unproductive attempt to upright #32 with cross-elastics.

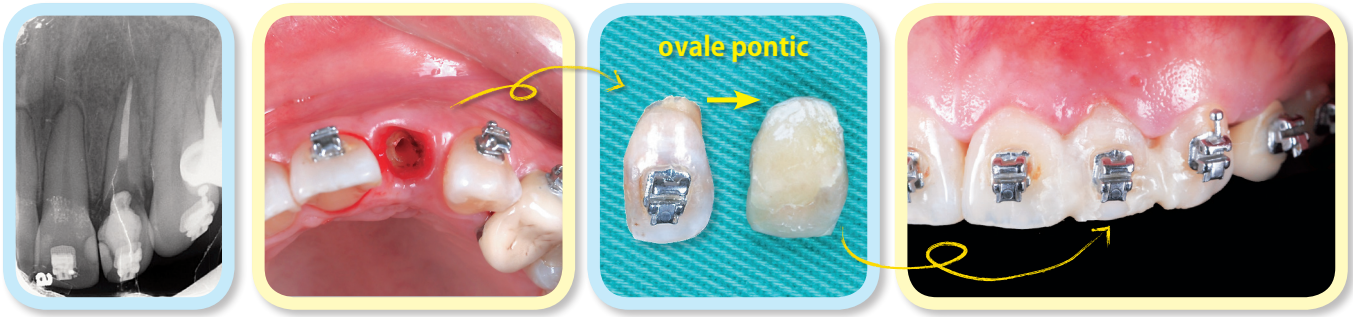


Fig. 21:

Internal resorption of the lateral incisor, that was first noted at 6 months of treatment (Fig. 14), progressively weakened the incisor which was also used to secure a bite turbo. Subsequently the tooth fractured due to the moment produce by the turbo lever arm. The unfavorable fracture and internal root resorption precluded a forced eruption followed by a post and core procedure. To prevent the collapse of the soft tissue, the cervical portion of the fractured crown was filled with composite resin and smoothed to form an pontic, that was bonded immediately to the adjacent teeth with flowable resin.

was shaped to simulate an oval pontic and it was bonded interproximally to the adjacent teeth.

Implant Placement

Presurgically, the gingiva surrounding the residual root of #10 was assessed as flat with a thick gingival bio-type. The fistula was near the mucogingival junction and the tissue surrounding it was inflamed (*Fig. 21*). The overbite and overjet had been corrected to a minimal overlap favorable for the implant placement. Radiographic slices from the CT scan showed the alveolar process of the residual root was intact at the crest and was ~1mm thick along the facial surface, except for the area of the apical

fenestration (*Fig. 22*).

According to the 2B-3D rule, the implant was inserted virtually into a slice of the CT scan to confirm the diameter and length of the fixture, consistent with the ideal prosthetic position of the implant-supported crown. The angulation and location of the fixture were duplicated on the cast, as well as the clear surgical stent (*Figs. 22-23*).[5]

Before implant placement, a relatively atraumatic removal of the residual root was performed. The tooth-connected residual fibers were severed with a #15c blade, and the root was sectioned into palatal and facial fragments with a high speed handpiece. First the palatal fragment was removed gently by inserting an elevator (*periotome*) in the mesial and distal periodontal ligament space (*Fig. 24*). Subsequently, the facial fragment was more easily removed, without harming the integrity of the labial plate of bone. After extraction of the root segments, all of the granular tissue and residual debris were removed with a surgical bone excavator and curettes. The labial surface of the alveolus was gently

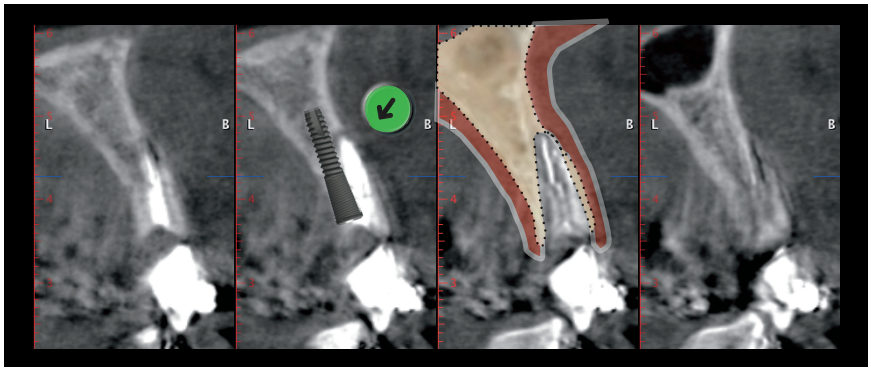


Fig. 22:

To determine the appropriate diameter and length of the proposed fixture, implant placement was simulated with the central slice for the CBCT scan. The alveolar process was adequate to receive the fixture except for the area of the fenestration (green arrow).

Fig. 23: A clear surgical stent was fabricated to guide the path for the osteotomy burs.

Fig. 24:

A relatively atraumatic extraction of the root fragment was facilitated by sectioning it in the mesio-distal plane with a high speed handpiece. Then the palatal and facial portions of the root were easily removed.

probed to detect the apical perforation due to the fistulous tract (*Fig. 25*).

With a clear surgical stent, the initial osteotomy in the palatal wall of the socket was made with a round bur. The path of the fixture insertion was carefully prepared step-by-step. Before implant placement, the apical perforation of the labial plate was filled with compacted, platelet-rich fibrin (*PRF*) membranes. Then the fixture, 3.8mm in diameter and 14mm in length, was inserted; however, its flared inclination was unacceptable. The fixture was removed and the insertion pathway was corrected with a side-cutting Lindemann drill (*Fig. 26*). The fixture was then seated with a torque of > 35 N-cm, and fitted with a solid abutment, inserted with a torque of 25 N-cm (*Fig. 27*). The surface of the plastic healing cap was roughed. Then flowable composite was added and polymerized, layer by layer, to fit the coronal shape and contour of the extraction socket (*Fig. 28*). The final provisional restoration was fitted, carefully inspected intraorally, and polished with a rag wheel to a smooth, semi glossy surface. Before seating the provisional restoration, additional PRF membranes were packed on the buccal side of the fixture to fill the gap between the fixture and the alveolar crest of bone. This step is important for : 1. preventing exuded cement form filling the space

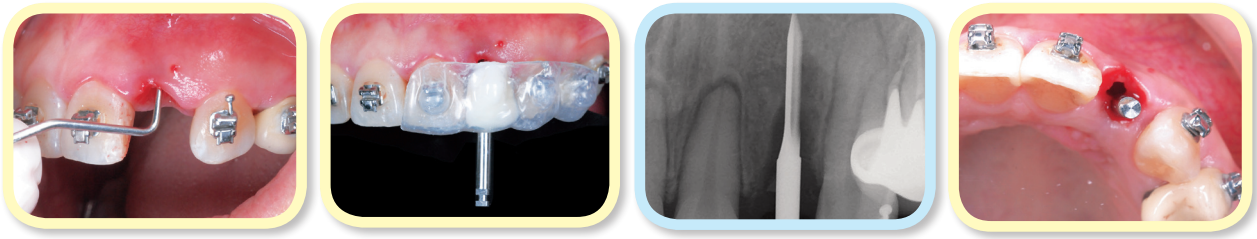


Fig. 25: The residual debris was removed from the alveolus and the surgical stent was used to guide the osteotomy.

Fig. 26:

Compacted PRF membranes were placed into the apical fenestration, and the fixture was seated, but its angulation was excessively labial. A Lindemann drill with side-cutting ability was used to extend the ostectomy into the palatal wall to correct the angulation of the fixture.

Fig. 27:

After the probing depth to the fixture was confirmed to be at least 3mm below the gingival margin, the abutment was fitted to the fixture with a torque of 25 N-cm. This is an important step because the submerged portion must be well sealed to avoid microbe contamination.

and compromising the healing of the periodontium, and 2. capturing a blood clot in the labial defect which will achieve new bone formation via vascular invasion. To stimulate a positive gingival response, the provisional restoration was fitted on the replica (*analog*), which was identical to the intraoral one (*Figs. 29-30*).

Orthodontic Finishing Stage

In the 34th month, a .017"x.025" TMA upper archwire was placed for finishing adjustments. The lower arch received a .016"x.022" stainless steel archwire. One month later, the attachment on #30 (*mesially repositioned #32*) was changed from a third molar tube to a first molar bracket, and a .017"x.025" TMA archwire was inserted. The upper right third molar

Fig. 28:

The surface of the healing cap was roughed, and flowable resin was added incrementally to form the provisional crown. Then it was carefully smoothed, especially the portion below the gingiva margin.

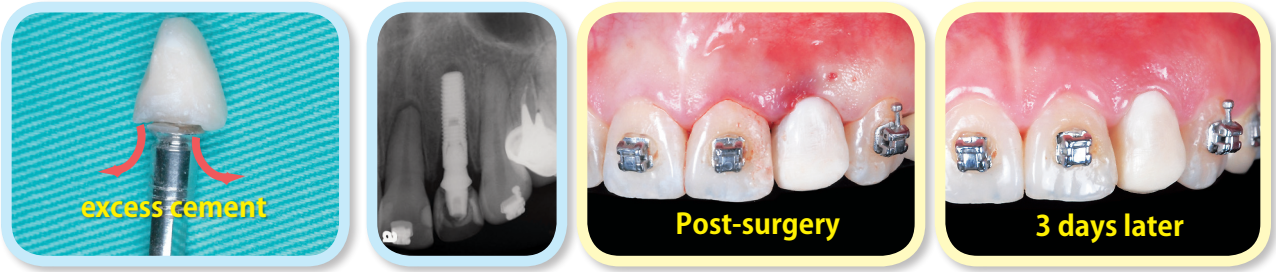
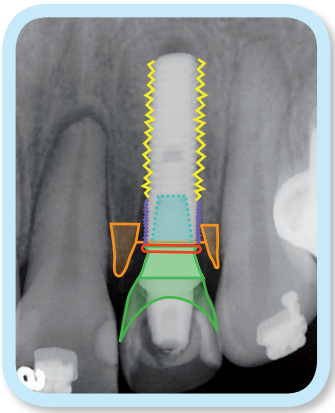


Fig. 29:

The cement-type provisional restoration was filled with the temporal cement and seated extraorally to extrude the excess cement. Once the provisional crown was seated, the gingival ecchymosis returned to pink after three days.



- *Macro-thread design for the primary stability.*
- *Micro-thread design for reducing the crestal stress during loading.*
- *Conical seal at the implant-abutment interface to reduce micro-motion and microbes contamination.*
- *Platform switching to reduce marginal bone level alterations.*
- *Adequate Inter-dental implant distance to maintain the interproximal bone and papilla.*
- *Smooth emergence profile to seal-off the underlying tissue and help achieve soft tissue adherence.*

Fig. 30:

A schematic drawing, superimposed on the radiograph, is color coded to show the geometric design of an optimal immediate implant placement.

was then extracted.

In the 40th month, all fixed appliances were removed and clear retainers were delivered. Following completion of the final crown for the #10 implant, new clear retainers were made.

Implant Prosthesis Fabrication

There was an uneventful healing of the surgical area during the final stages of the orthodontic treatment. Six months later, the integrity of the soft and hard tissue were optimized by the delicate implant placement procedures. The outcome of the esthetic zone had a natural appearance due to the careful immediate implant placement. The provisional restoration was removed for an impression, and the gingival sulcus around the abutment was healthy (*Fig. 31*). Adequate height of the gingival margin was achieved superior to the shoulder of the abutment, which is important for avoiding the unfavorable display of the metal collar. Subsequently, a direct impression was made utilizing braided cord for gingival retraction (*Fig. 32*). To ensure adequate thickness of the definitive crown, adequate clearance was prepared on the abutment with a high speed handpiece, and its surface was polished until smooth. The exact replica of the abutment and its surrounding soft tissue and dentition was made with a polyvinyl siloxane impression, that was subsequently poured with gypsum that had been mixed with water (*stone*). A week later, a full ceramic crown was fitted, and the abutment and carefully inspected. The permanent crown showed some occlusal and contour discrepancies. The porcelain surface was adjusted and stained to achieve adequate occlusal contact and esthetics, as well as to develop a profile that was consistent with the adjacent teeth. The desired morphology was carefully developed to achieve a natural appearance (*Fig. 33*). The crown was luted and the restoration was assessed with respect to occlusal and esthetic details, relative to adjacent teeth. After sounding to the crest bone and calculating the essential 3mm biologic width, a diode laser was used to perform gingivoplasty.[6] Removal of less than 1mm of the

Fig. 31:
Four months later, the jumping distance (gap between the alveolar wall and the implant surface) was filled with new bone, and the healthy gingival sulcus could be packed gently with braided cord for abutment preparation.

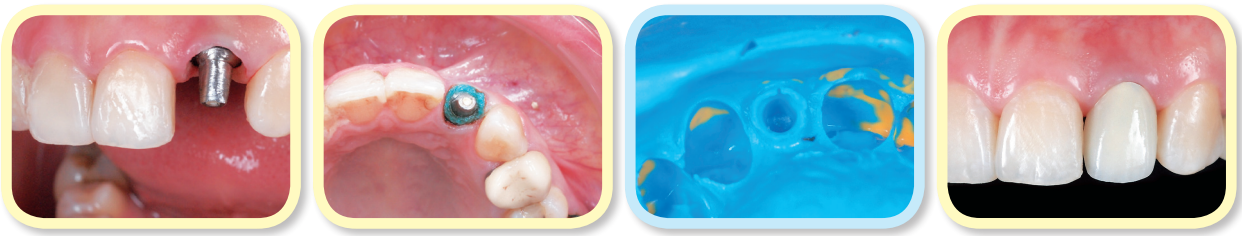


Fig. 32: Double cords were packed to achieve a direct impression with well defined margins to achieve a well fitting prosthesis (crown).

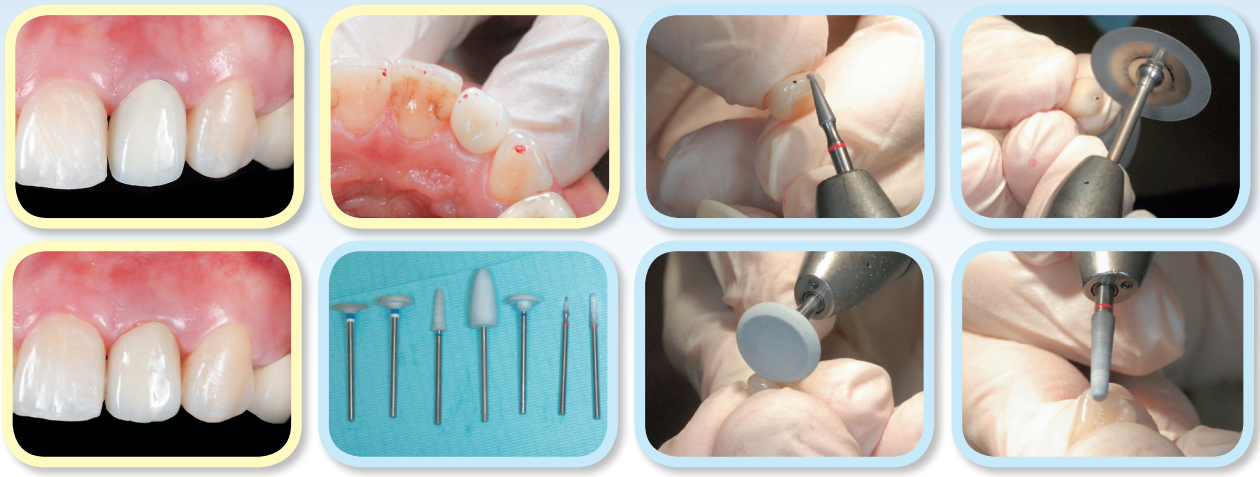


Fig. 33:

Final subtle adjustments for the definitive restoration achieved a light occlusal contact, and the appearance of the restoration that was in harmony with the adjacent natural dentition.

Fig. 34:

The biological width for all the incisors was measured by sounding to the alveolar crest of bone. Since there was excess marginal gingiva, a modest gingivectomy and gingivoplasty were performed with a diode laser.

gingival margin of the three adjacent natural incisors dramatically improved the "*pink and white*" esthetics (*Fig. 34*).[7,8]

Results Achieved

Maxilla (*all three planes*):

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

Mandible (*all three planes*):

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

Maxillary Dentition

- Alignment: #8 rotated distal side out
- Anchorage: Maintained
- Incisor Control: Retracted and slightly intruded
- A - P: Retracted, although there was apparent interference of first molar roots with the bone screws (*Fig. 35*)
- Vertical: Molars intruded
- Intermolar Width: Increased
- Intercanine Width: Maintained
- Buccolingual Inclination: Acceptable
- Marginal Ridges: discrepancies on #4 & 5

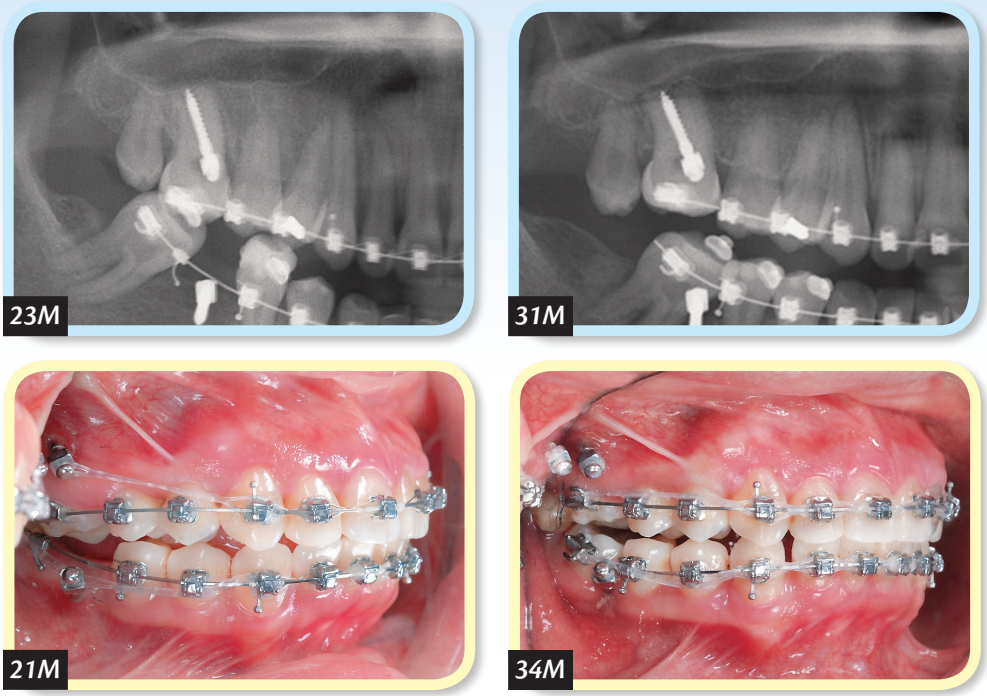


Fig. 35:

The upper right second molar was constantly intruded from the 21st to 34th month, but then intrusion ceased probably because the roots of the molar were in contact with the bone screw. If further intrusion was needed, repositioning of the bone screw is indicated.

Mandibular Dentition

- Alignment: #26 rotated distal side out
- Anchorage: molars moved mesially
- Incisor Control: Intruded
- A - P: Retracted
- Vertical: Molars extruded
- Inter-molar Width: Increased
- Inter-canine Width: Increased
- Buccolingual Inclination: Acceptable
- Marginal Ridges: discrepancies on #19 & 20

Facial esthetics: Lip profile was decreased.

Superimposition: The maxillary dentition was retracted and the lower incisors were intruded. Anchorage was preserved as needed by the bone screws. The lower left third molar was protracted as planned. Despite extensive use of Class II elastics and anterior bite turbos, the vertical dimension of occlusion was not increased, primarily because of bone screw anchorage. No mandibular growth was detectable. Class I molar relationship was achieved consistent with ideal overjet and overbite. The protrusive lips were retracted to achieve a more attractive profile (*Figs. 7-9*).

Retention

As prescribed in the treatment plan, upper and lower clear overlay retainers were delivered after the fixed appliances were removed. A new clear maxillary overlay retainer was made after the completion of the implant-supported crown. The patient was instructed to wear the 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 major discrepancies in the anterior segments were corrected to a normal alignment, overjet and overbite. All extraction spaces were closed and the upper dental midline was corrected relative to the facial and mandibular midlines. The gingival texture was healthy with improved esthetic contours.

The ABO Cast-Radiograph Evaluation (*CRE*) score was 15 points, as documented on the form appearing later in this report. The outcomes were considered an excellent result for a malocclusion with an initial DI of 61. However, the following deviations from ideal were noted: [9]

- The upper right central incisor was rotated distal in, and the lower left incisor was rotated distal out.
- Marginal ridge discrepancy existed between the upper right (#*4 & 5*) and lower left segments (#*19 & 20*).
- Excessive buccal overjet was observed for both maxillary first molars.
- Occlusal contact was absent for the lower left 2nd bicuspid.
- The occlusal relationship was Class II for the maxillary right first molar through canine (#*3-6*) (*Fig. 36*).
- Root angulation discrepancies were observed for the left lateral incisor and lower 2nd bicuspid.

Discussion

In Taiwan, adult orthodontic treatment is often complicated by missing teeth and caries, secondary to a compromised diet with a high sugar content. The major problems for the present patient were intermaxillary crowding, protrusive lips, multiple missing teeth, and residual roots of maxillary molars. The treatment priority was to achieve optimal function and esthetics with minimum implants, prostheses and treatment time. Treatment planning focused on the protrusive profile, high

Fig. 36:

The occlusal interdigitation relationships were Angle Class I on the left side, but there was still a Class II tendency on the right side. The upper anterior soft tissue showed bilateral symmetric curvatures except for a moderate root prominence of the immediate implant-supported crown that replaced tooth #10.

mandible angle and severe crowding. Hopeless and significantly damaged teeth were extracted.[10] Anchorage control for closing the spaces was challenging. Initially bite turbos were used to open the interocclusal space to enhance the alignment of the anterior segments. The most significant problems were the protrusive maxillary dentition with 6.5mm overjet, lingually inclined lower right third molar (#32), and the 17mm edentulous space mesial to the lower right third molar.

In the first 10 months of treatment, it was clear that the cross elastics were inadequate to upright the lower right third molar (#32). Furthermore, Class II elastics were inefficient to retract the upper dentition. A bone screw in the right buccal shelf provided anchorage to upright #32 in three months. Bilateral bone screws in the infrazygomatic crests offered adequate anchorage for en masse retraction of the maxillary dentition.[11]

This Class II deep-bite malocclusion with posterior crossbite had significant discrepancies in all three planes of space. According to Parker,[12] overbite correction often results in intrusion of the incisors, extrusion of the posterior teeth, and increased axial inclination of the incisors. These effects can be seen with a variety of appliances: intrusive arch, utility arch combined with high pull head gear, J-hook head gear, or miniscrew anchorage.[12] For the present patient, utilizing bite turbos to disarticulate the occlusion resulted in an effective correction of the overbite, without excessive flaring of the lower incisors.

Where can bite turbos be placed and how thick should they be? For the present patient, bite turbos of at least 5mm in thickness were bonded on the upper second premolars to prevent interference of the extruded right maxillary molar with the lower .014"x.025" CuNiTi archwire. Subsequently, there was adequate occlusal clearance for the rectangular lower CuNiTi archwire to torque the tilted molar into an upright position. The mandibular plane angle did not increase because of the intrusive effect of the posterior bite turbos. The TMJ was closely monitored at each recall visit and no negative effects were observed.

In assessing the final result, substantial edentulous ridge space was closed in the lower arch, and the whole upper dentition was successfully retracted using bone screw anchorage. The occlusal relationship on the right side was Class I, but on the left a residual Class II relationship was noted (*Fig. 36*). The upper dental midline was aligned with both the facial and lower dental midlines. The total CRE score was 15 points, which is an excellent result for a difficult malocclusion. From panoramic images at 21 and 32 months, it was determined that the upper right second molar was not continuing to intrude despite force from the infrazygomatic crest (*IZC*) screw (*Fig. 35*). If further intrusion were needed, it would be necessary to reposition the IZC screw to avoid interfering with the roots of the upper right second molar. A cone beam CT image would be necessary to look for an appropriate, new location for the IZC screw to permit further intrusion of the posterior maxillary dentition.[11]

When large posterior spaces are closed in the lower arch, lingual tipping of the incisors is a frequent problem. The 6.5mm overjet, anterior crowding and Class II buccal segments were corrected with Class II elastics, bone screws and bite turbos. Correction of the anterior crowding reduced the tendency for lingual tipping of the lower incisors. Using a bone screw as anchorage to protract the third molar to close the edentulous space also help prevent the lower incisors from tipping lingually. In brief, bone screw anchorage was essential for maintaining an appropriate inclination and sagittal position of the lower incisors over the apical base of bone. Because of the mechanics employed, standard torque brackets were adequate for the lower incisors.

The velocity at which a tooth moves is limited by the linear rate of resorption at the PDL/bone interface.[13] Roberts et al.[13] reported that: (*1*) sustained orthodontic translation is a physiological manifestation of bone modeling and remodeling throughout the adjacent alveolar process, and (*2*) the rate of mandibular molar translation is inversely related to the apparent radiographic density of the resisting alveolar bone. These concepts were applicable for treatment the present patient. Especially, in the final stage of the movement, there was increased radiographic density of the resisting alveolar bone between the second bicuspid and molar, that slowed the rate of tooth movement as the space was closed.[13]

The pulp necrosis and fracture of #10 was a major complication in treating the present patient. Magnification and careful examination of the pretreatment panoramic radiograph (*Fig. 7*) reveals a faint radiolucency, consistent with the well-defined lesion in Fig. 14. Although asymptomatic initially, the tooth may have already been compromised before treatment. Superimposing a bite turbo (*Fig. 15*) may expose a tooth to significant occlusal trauma, because a long lever arm on the turbo may be necessary to provide a centric stop with the lower incisors. The moment due to the occlusal force is proportional to the length of the lever arm. The mechanical effect is a production of rotation at a point apical to the center of resistance of the root (*center of rotation*). The traumatic occlusion due to the bite turbo may have enhanced the degeneration of the pulp, precipitating infection, pain and a fistulous tract. A search of PubMed failed to produce any reports on pulp necrosis associated with bite turbos. However, there are recent reports that traumatized maxillary incisors, especially lateral incisors, have a higher susceptibility to pulp necrosis during orthodontic intrusion than non-traumatized teeth.[14, 15] Bite turbos in the anterior region clearly concentrate occlusal forces and moments on the affected teeth, which may jeopardize the vitality of pulp.

In the fourth month of treatment, the anterior bite turbo on the left side was moved from the canine to the adjacent lateral incisor (#*10*). Signs and symptoms of a periapical abscess occurred, and the tooth was treated endodontically. Following root canal treatment, the lateral incisor was still used as a bite turbo. Occlusal force on the turbo produces

an intrusive force on the tooth, as well as a moment, that is proportional to the distance from the long axis of the tooth to the point of of occlusal contact on the turbo. The moment results in a cyclic flexure of the root that tends to create fatigue damage below the alveolar crest. The occlusal trauma may also have been a factor in the internal root resorption noted when the incisor fractured (*Fig. 21*).

Once the root fracture occurred, it was necessary to consult Dr. Chang's decision making tree for evaluating deficient roots (*Fig. 37*).[16] First it is important to consider the reason for the root fracture: trauma, root caries and/or root resorption. The proportionality of the final prothesis requires at least a 4mm length for a sufficient ferrule effect, and to achieve the proper biological width. If the root fragment is deficient in this regard, it should be evaluated for an appropriate prosthetic procedure. Extraction, direct crown lengthening or forced eruption may be necessary.[17] The deficient roots can sometimes be submerged to secure appropriate soft and hard tissue esthetics of a multiple-unit fixed.[18, 19]

Both patients and clinicians desire implant-supported restorations that provide optimal function and esthetics. Tarnow[20] divided maxillary extraction sockets into three types, according to the presence or absence of the buccal and hard palate bone, as well as adequate soft tissue. The socket type affects decisions relative to treatment timing and choosing the proper operative procedures.[20] A type I extraction socket has thick soft tissue and well-defined alveolar crest margin. Basilar bone beneath the alveolar process can also provide primary stability for the implant fixture. Applied to

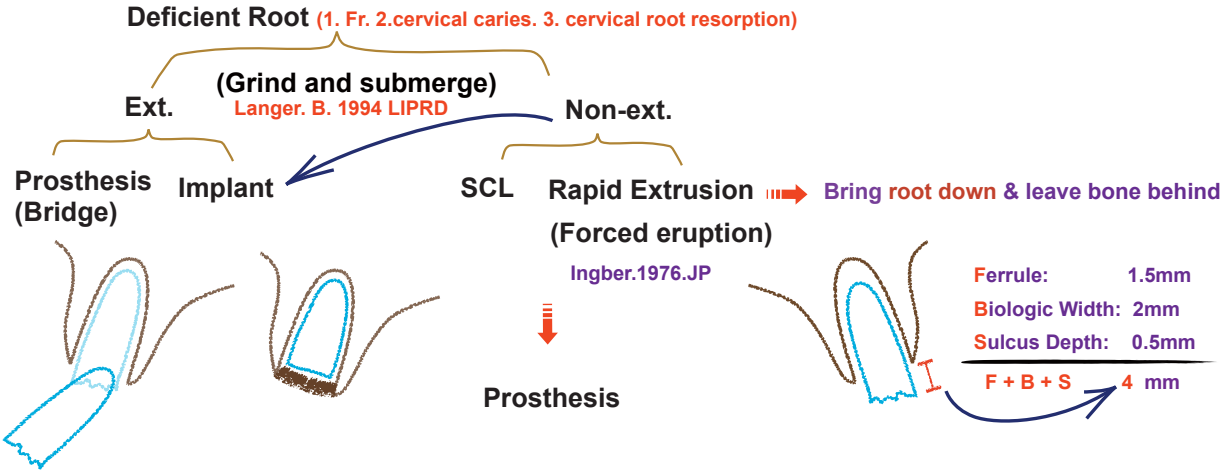


Fig. 37:

The decision making tree (Chang[16]) shows that the residual length of the deficient root caused from fracture, cervical caries and cervical root resorption. The crown/root ratio can be anticipated by subtracting the essential distance of 4mm. The roots with favorable crown/root ratio can be preserved for further treatment via surgical crown lengthening or rapid extrusion. The roots with an unfavorable ratio should be extracted in preparation for an implant placement or prosthesis. Alternatively, deficient roots can be submerged to preserve alveolar bone and provide a platform for gingival healing. Subsequently the site can be restored with an implant or multiple unit prostheses.

the present patient, a careful clinical examination, plus an implantation simulation utilizing the CT slice of the site, helped determine the optimal prosthetic approach. Immediate implant placement was indicated to achieve optimal function, as well as a favorable esthetic outcome, within a relatively short treatment duration.

Placing an implant fixture in a fresh extraction site usually results in a gap between the alveolar crest and the fixture. Unless this defect fills with bone, the outcome may be recession, resulting in esthetic compromise, or even implant failure.[21] Maintenance of the original buccal and vertical bone volume is best achieved with a flapless surgical approach. For the present patient, this method was preferred to: 1. maintain the blood supply, 2. allow for a good 3D positioning of the fixture at 3mm depth below the gingival margin, 3. preserve 2mm of buccal bone thickness, and 4. provide for a 1.5mm distance to the adjacent teeth to preserve optimal healing and growth potential for the gingival complex.[5, 22, 23] However, the alveolus for the present patient had a labial defect due to the fistulous tract (*to be subsequently discussed*), and a gap at the alveolar crest between the implant and supporting bone. A recent article by Araújo, Linder, and Lindhe[24] suggests that a xenograft material can be used in the gap between the bone wall and implant surface. These particles may be incorporated into the soft tissue without any inflammatory reaction and maintain the esthetic profile.

Platelet Rich Fibrin (*PRF*) contains not only varied cytokines, beneficial to the inflammatory and healing processes, but also fibrin matrix which supports angiogenesis, immunity, and epithelial covering of the wound.[25] In general, placing bone graft particles covered with resorbable collagen membranes, via VISTA (*Vestibular Incision Subperiosteal Tunnel Access*)[26] or an Esthetic Buccal Flap,[27] is appropriate for repairing apical fenestrations. However, the apical defect in the present case was not threatening the stability of the implant fixture because of the wide base of the alveolar process, thick buccal crest bone, and soft tissue with a favorable biotype. Thus PRF membranes without bone graft material were packed in to the alveolar crest gap and the apical fenestration to enhance bone fill and healing of the soft tissue. It is important to remember that resorption of xenograft materials may be slow and unpredictable, so good surgical technique to capture a blood clot to promote natural bone healing may be the best approach.

Another key to success is the coronal seal of the socket by the provisional prosthesis. Once the chosen abutment is fitted in the fixture, it is best to use an immediate provisional restoration, with a smooth emergence profile. Adapt it to the wound without pressure and do not remove it until the bone maturation is complete. Subsequently, tissue adherence between the abutment and soft tissue occurs, presumably via hemi-desmosomes. Close approximation of the soft tissue to the implant abutment helps preserve the optimal volume of new bone.[28, 29, 30] In general, the conical seal design reduces the micro-movement and pumping effect,

which can introduce unfavorable microbes.[31] The screw-retained provisional restoration is superior to a cemented one, because the latter can cause an inflammatory reaction, due to excessive cement coating the submerged base of the abutment.[32] It may be difficult to avoid a cemented provisional restoration, particularly if there is an unfavorable angulation of the fixture. In this circumstance, an extraoral pre-cementation procedure or under-cementing the union is recommended (*Fig. 29*).

Six months later, the permanent restoration was delivered. When the provisional restoration was removed, a slight recession was noted. However, there was a satisfactorily buccal gingival contour of the implant-supported crown, compared to the natural right lateral incisor. Overall, the outcome was acceptable and will be periodically reevaluated in years to come (*Fig. 36*).

Conclusion

This complex malocclusion was challenging to resolve. It required careful diagnosis and treatment planning to devise a realistic approach for achieving optimal esthetics and function, consistent with minimal prosthetics and treatment time. The facial objectives, reducing lip protrusion and maintaining the vertical dimension of occlusion, were achieved by utilizing bone screw anchorage. The fracture and loss of the maxillary left lateral incisor was disappointing, but the immediate implant-supported crown had a good outcome. In retrospect, it is very important to carefully evaluate all teeth to be fitted with bite turbos, particularly maxillary lateral incisors, because they are susceptible to excessive flexure, which may compromise vitality and lead to fatigue failure. Overall, the final occlusion, function and esthetics were considered to be an optimal, cost-effective result. However, treatment efficiency could have been improved by 1. avoiding the 10 month attempt to correct the buccal crossbite with cross elastics, 2. bonding a first molar bracket on the lower right third molar, and 3. using more durable teeth for the bite turbos. Finally, it was clear that preprosthetic orthodontics was essential for the excellent, cost-effective outcomes. The patient was well satisfied with the results.

Acknowledgement

Thanks to Mr. Paul Head for proofreading this article.

References

1. Chang CH, Roberts WE. Orthodontics [E-reader version]. Hsinchu: Newton's A Ltd; 2012.
2. Pitts T. Begin with the end in mind: Bracket Placement and early elastics protocols for smile arc protection. Clinical Imprssions 2009;17:4-13.
3. Steffen JM, Haltom FT. The five-cent tooth positioner. J Clin Orthod 1987;21(8):528-529.
4. Kurth J, Kokich V. Open gingival embrasures after orthodontic treatment in adults; Prevalence and etiology. Am J Orthod Dentofacial Orthop 2001;120:116-23.
5. Chang CH. The 2B-3D rule for implant planning, placement and restoration. IJOI 2012;27:79-101.
6. Gargiulo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans J Periodontol 1961;32:261-267.

7. Saver DM. Yanosky M. Principles of cosmetic dentistry in orthodontics: part 2. Soft tissue laser technology and cosmetic gingival contouring. Am J Orthod Dentofacial Orthop 2005;127:85-90.
8. Su B. IBOzzI Pink &White esthetic score. IJOI 2012;28:96-101.
9. Chang CH. Advanced Damon Course No. 6: CRE worhshop. Beethoven Podcast Encyclopedia in Orthodontics [podcast]. Hsinchu: Newton's A Ltd; 2011.
10. Chang CH. Advanced Damon Course No. 1: Crowding: Ext. vs Non-ext. Beethoven Podcast Encyclopedia in Orthodontics [podcast]. Hsinchu: Newton's A Ltd; 2011.
11. Lin JJ. Creative Orthodontics Blending the Damon System and TADs to manage difficult malpositions 2nd edition 2010 p. 187-207.
12. Parker CD, et al. Skeletal and dental changes associated with the treatment of deep malocclusion. Am J Orthod Dentofacial Orthop 1995;107:382-93.
13. Roberts WE. Rate of translation of mandibular molars using implant-anchored mechanics. The Angle Orthod 1996;66:331-37.
14. Bauss O, Röhling J, Meyer K, Kiliaridis S. Pulp vitality in teeth suffering trauma during orthodontic therapy. Angle Orthod 2009;79(1):166-71.
15. Bauss O, Röhling J, Sadat-Khonsari R, Kiliaridis S Influence of orthodontic intrusion on pulpal vitality of previously traumatized maxillary permanent incisors.. Am J Orthod Dentofacial Orthop 2008;134(1):12-7.
16. Chang CH. Implant Forum III No. 31: Ortho-implant Q.A. Beethoven Podcast Encyclopedia in Orthodontics [podcast]. Hsinchu: Newton's A Ltd; 2012.
17. Ingber JS. Forced eruption: Part II. A method of treating nonrestorable teeth—Periodontal and restorative considerations. J Periodontol 1976;47:203–216.
18. Langer B. Spontaneous in situ gingival augmentation.Int J Periodontics Restorative Dent 1994;14(6):524-35.
19. Salama M, Ishikawa T, Salama H, Funato A, Garber D. Advantages of the root submergence technique for pontic site development in esthetic implant therapy. Int J Periodontics Restorative Dent 2007;27(6):521-7.
20. Elian N, Cho SC, Froum S, Smith RB, Tarnow DP.A simplified socket classification and repair technique.Pract Proced Aesthet Dent. 2007;19(2):99-104.
21. Araújo MG, Sukekava F, Wennström JL, Lindhe J. Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. J Clin Periodontol. 2005;32(6):645-52.
22. Tarnow DP, Cho SC, and Wallace SS. The Effect of Inter-Implant Distance on the Height of Inter-Implant Bone Crest. Int J Periodontics Restorative Dent 2008;28(2):123-35.
23. Grunder U, Gracis S, Capelli M. Influence of the 3-D bone-to-implant relationship on esthetics.Int J Periodontics Restorative Dent 2005;25(2):113-9.
24. Araújo MG, Linder E, Lindhe J. Bio-Oss collagen in the buccal gap at immediate implants: a 6-month study in the dog. Clin Oral Implants Res 2011;22(1):1-8.
25. Choukroun J, Diss A, Simonpieri A, Girard MO, Schoeffler C, Dohan SL, Dohan AJ, Mouhyi J, Dohan DM. Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part IV: clinical effects on tissue healing. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101(3):56-60.
26. Zadeh HH. Minimally invasive treatment of maxillary anterior gingival recession defects by vestibular incision subperiosteal tunnel access and platelet-derived growth factor BB.Int J Periodontics Restorative Dent 2011;31(6):653-60.
27. Steigmann M, Wang HL. Esthetic buccal flap for correction of buccal fenestration defects during flapless immediate implant surgery. J Periodontol 2006;77(3):517-22.
28. Abrahamsson I, Berglundh T, Lindhe J. The mucosal barrier following abutment dis/reconnection. An experimental study in dogs. J Clin Periodontol 1997;24(8):568-72.
29. Trimpou G, Weigl P, Krebs M, et al. Rationale for esthetic tissue preservation of a fresh extraction socket by an implant treatment concept simulating a tooth replantation. Dent Traumatol 2010;26(1):105-111.
30. Chu SJ, Salama MA, Salama H, Garber DA, Saito H, Sarnachiaro GO, Tarnow DP. The dual-zone therapeutic concept of managing immediate implant placement and provisional restoration in anterior extraction sockets. Compend Contin Educ Dent 2012;33(7):524-32, 534.
31. Zipprich H, Weigl P, Lauer H-C, Lange B. Micro-movements at the implant-abutment interface: measurements, causes and consequenses. Implantologie 2007;15:31-45.
32. Wilson TG Jr. The positive relationship between excess cement and peri-implant disease: a prospective clinical endoscopic study. J Periodontol 2009;80(9):1388-92.

Discrepancy Index Worksheet

TOTAL D.I. SCORE 61

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 = 3

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	____ pts.
Full Class II or III	=	4 pts. per side	____ pts.
Beyond Class II or III	=	1 pt. per mm. additional	____ pts.

Total = 8

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 2

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° ____ x 1 pt. = ____

Each degree > 6° 1 x 1 pt. = 1

SN-MP

≥ 38° = 2 pts.

Each degree > 38° 7 x 2 pts. = 14

≤ 26° = 1 pt.

Each degree < 26° ____ x 1 pt. = ____

1 to MP ≥ 99° = 1 pt.

Each degree > 99° 3 x 1 pt. = 3

Total = 25

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)	5	x 1 pts. =	5
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. =	5

Identify: Lingual collapsed lower right third molar correction

Total = 10

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) = ____

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) sufficient in the extraction socket with the apical perforation = 2

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

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

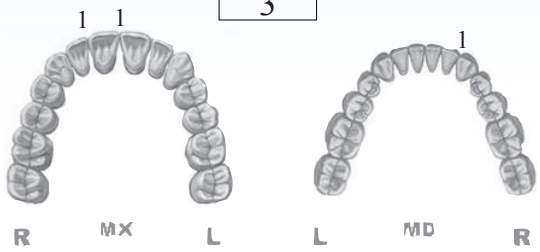
Total = 4

Cast-Radiograph Evaluation

Total Score: 15

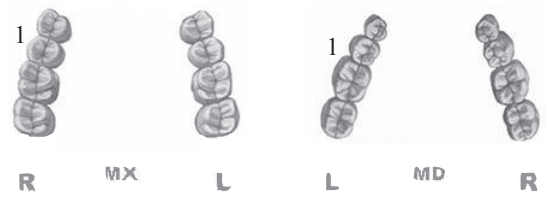
Alignment/Rotations

3



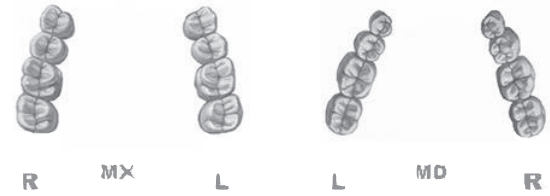
Marginal Ridges

2



Buccolingual Inclination

0

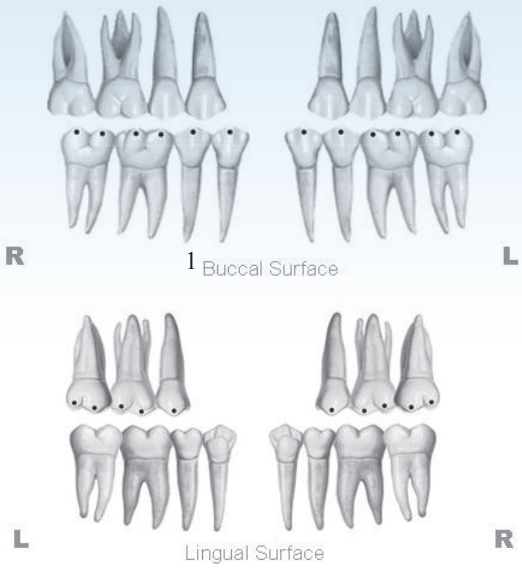


Overjet

3

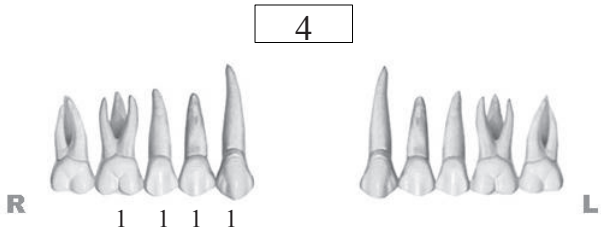
Occlusal Contacts

1



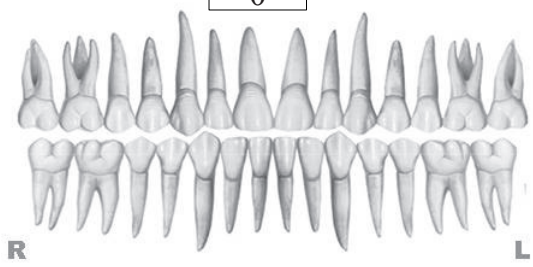
Occlusal Relationships

4



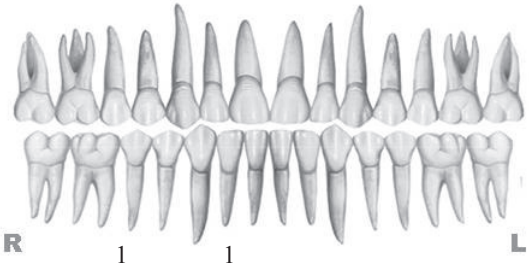
Interproximal Contacts

0



Root Angulation

2

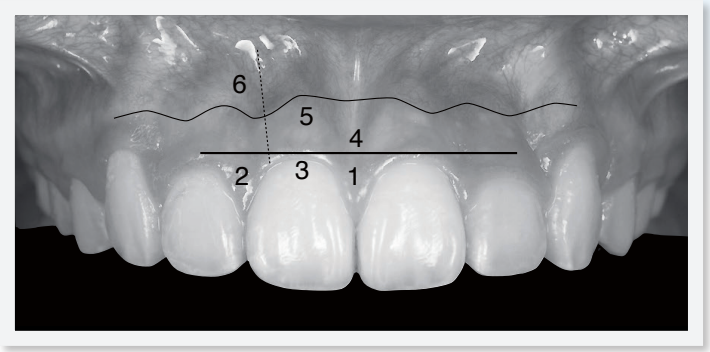


INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: = 2

1. Pink Esthetic Score

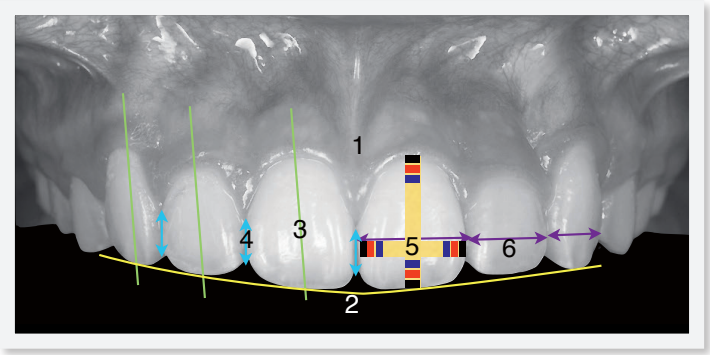


Total = 0

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

1. M & D 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)



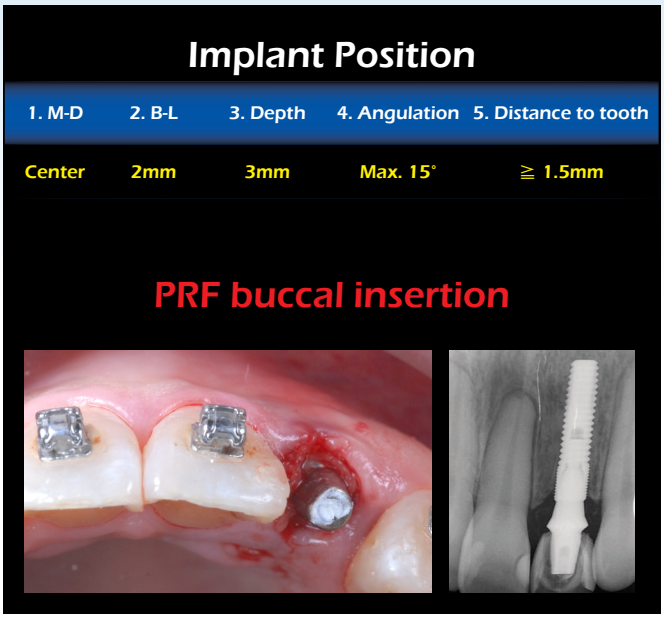
Total = 2

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

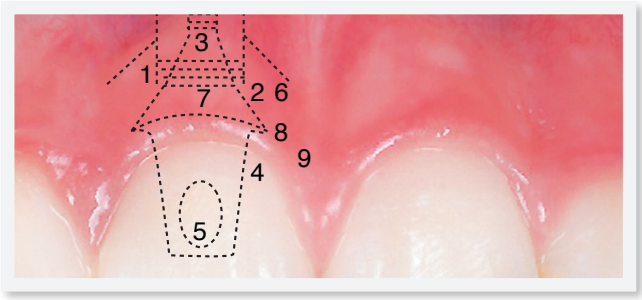


Total = 0

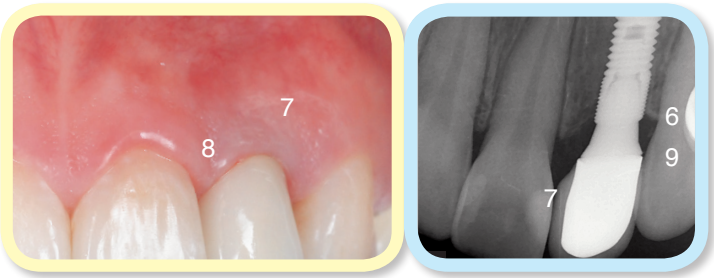
1. M & D (Center)	0	1	2
2. B & L (Buccal 2 mm)	0	1	2
3. Depth (3 mm)	0	1	2
4. Angulation (Max. 15°)	0	1	2
5. Distance to Adjacent Anatomy	0	1	2

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				bone level
2. Platform Switch	N	(Y)				platform
3. I-A Connection Type	E	(I)				11° morse taper
4. Abutment Selection	S	(C)				cement-retained
5. Screw Hole Position	P	B				incisal edge
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	