Protrusive Partially Edentulous Malocclusion: Early Loss of a Lower First Molar, Implant Site Development and VISTA Soft Tissue Augmentation

Abstract

Introduction: *A 29yr female presented with chief complaints of irregular teeth and a protruded chin. The upper right (UR) lateral incisor (#7) was congenitally missing and #10 was a peg lateral. The lower left (LL) first molar was apparently lost in childhood due to a developmental problem: molar-incisor hypoplasia (MIH).*

Diagnosis & Etiology: *The probable etiology of the anterior crossbite and midline deviation was the collapse of the left posterior dentition when the second deciduous molar was lost (~age 10-12yr). When there is a loss of posterior occlusal stops in the mixed dentition, children often posture anteriorly to achieve a more comfortable occlusion. Teeth #12 and 15 were subsequently lost to caries, which resulted in additional atrophic extractions sites.*

Treatment & Results: *The patient preferred conservative treatment with minimal surgery, and no temporary anchorage devices (TADs). Following extraction of an endodontically treated LR5 (#29), both arches were orthodontically retracted for space closure and correction of lip protrusion. The upper left second premolar (UL5) (#13) was translated anteriorly to create an implant site. Subsequently an osseointegrated fixture was placed in the prepared site, along with a simultaneous soft tissue augmentation procedure via the vestibular incision subperiosteal tunnel access (VISTA) technique. The UR canine (UR3) and first premolar (UR4) were reshaped and substituted for the missing lateral incisor and adjacent canine.*

Outcomes: *Following 42 months of interdisciplinary treatment, this difficult malocclusion with a Discrepancy Index (DI) of 27 was treated to an excellent cast-radiograph (CRE) score of 22. However, the Pink & White dental esthetics score was a relatively high 8 because of esthetic zone problems secondary to a midline discrepancy, that occurred because the patient declined miniscrew anchorage. (Int J Orthod Implantol 2017;45:24-56)*

Key words:
VISTA, implant site development, connective tissue graft, tuberosity graft, root coverage procedure, patient restrictions on treatment

Introduction

This case report contributes to a series of challenging malocclusions that were treated with an interdisciplinary approach.[1-16] They compose a variety of inherited and acquired disorders, such as skeletal discrepancies,[1-3] congenitally missing teeth, and[4,5] tooth size to arch length discrepancies.[6-8] A surprisingly common etiological factor is the early loss of permanent mandibular first molars (*lower 6s*), which is manifest as the loss of a posterior centric stop(*s*) when the second deciduous molars exfoliate (*~age 10-12yr*). Unilateral or bilateral occlusal instability may precipitate mandibular protrusion or retrusion to achieve more

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Fig. 1: Pre-treatment facial photographs

Fig. 2: Pre-treatment intraoral photographs

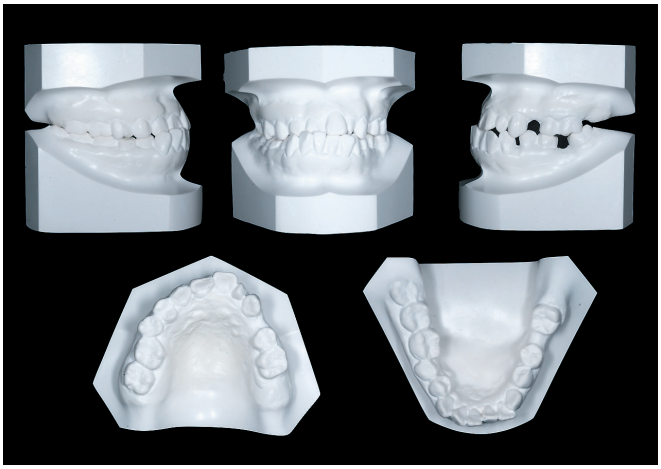
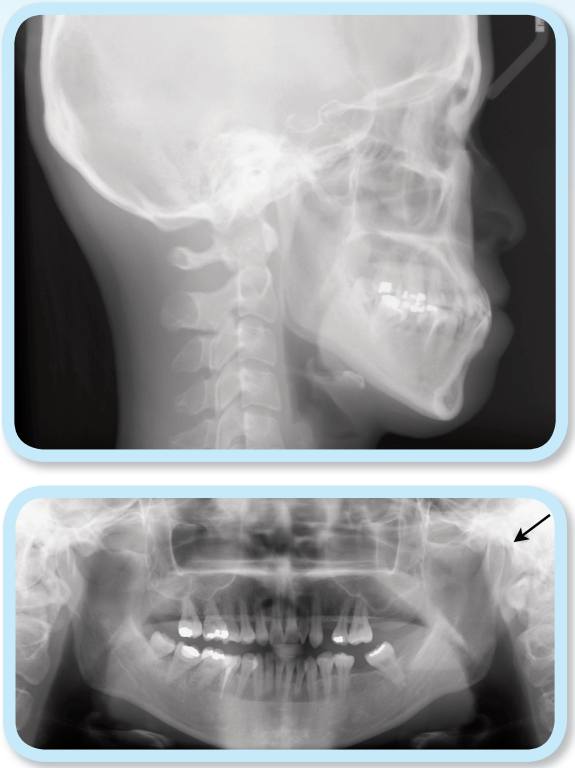


Fig. 3: Pre-treatment study models (casts)

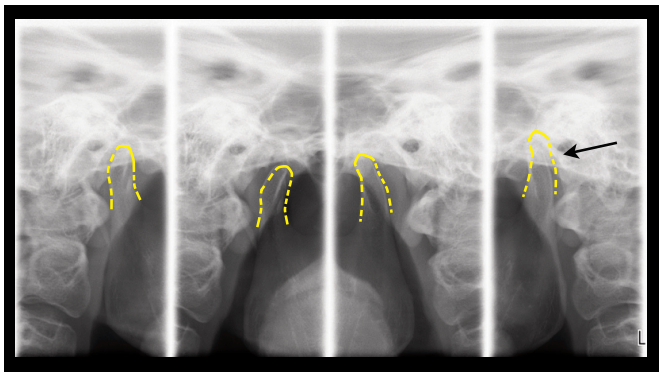
comfortable mastication. This acquired malocclusion may lead to a variety of dentofacial problems, such as orofacial asymmetry, mandibular protrusion or retrusion, and a deep curve of Spee.[1,9–11]

The present patient presented with a complex malocclusion (*Figs. 1-3*) featuring atrophic extraction sites (*Fig. 4*), multiple missing teeth (#*12, 15 and 19*) (*Fig. 5*), and asymmetric length of the mandibular condyles (*Fig. 6*). The missing lower left first molar (#*19*) was associated with a contralateral deviation of the mandible into anterior crossbite. Acquired characteristics of the complex malocclusion required a careful diagnostic assessment. Treatment planning was challenging because the orthodontic options were limited by restrictions the patient imposed on temporary anchorage devices (*TADs*), bone grafting and orthognathic surgery.

Fig. 4:
Posterior extraction sites are atrophic edentulous spaces.
Left: Maxillary second premolar (#12)
Right: Mandibular left first molar (#19)



■ *Fig. 5:*
Pre-treatment radiographs: cephalometric (upper) and panoramic (lower), note the left condyle (arrow) is ~1-cm longer than the right side.



■ *Fig. 6:*
The left two views are the Md condylar position on the right side in the closed and open positions, respectively. The right two views are the Md condylar position on the left side in the open and closed positions, respectively. The left condyle (arrow) appears to be longer than the right condyle, suggesting the left condyle was exposed to an environmental challenge such as anterior posturing of the Md.

Etiology: This is a critical consideration for all complex malocclusions. Crowding may be secondary to inadequate development of arch width[12,13] or an acquired crossbite.[7,8,10] Functional problems may result in aberrant physiologic biomechanics that contribute to progressive dental and skeletal malocclusion.[1-11] Determining the etiology of the disorder is an important prerequisite for designing an appropriate treatment plan. Developmental (*acquired*) malocclusion is most effectively treated by reversing the etiology that produced the problem(s). Many acquired skeletal malocclusions respond well to orthodontic anchorage, provided by extra-alveolar temporary anchorage devices (*E-A TADs*), but true genetic anomalies often require orthognathic surgery[14] or camouflage correction.[15] In addition, many patients have strong preferences for avoiding surgery, TAD anchorage, and may even decline extraction of periodontally compromised teeth.[16]

Periodontium: It is important to carefully assess the health of the periodontium to determine the potential for conservative correction, i. e. without extractions or orthognathic surgery. Periodontal evaluation revealed atrophic extraction sites (*Fig. 4*), and a loss of alveolar crest height in the mandibular anterior region, that was noted in the initial panoramic radiograph (*Fig. 5*). Poor hygiene was evidenced by extensive plaque deposits (*red stain*) noted interproximally throughout the mouth (*Figs. 7 and 8*). In addition, there were periodontal concavities (*blue arrows in Fig. 8*) on the buccal surfaces of the UL edentulous sites before (*0M*), as well as after mesial translation of tooth #13 to create

an implant site mesial to the molar. Adequate bone was produced for an implant. After mesial translation of tooth #13, mild soft tissue recession was noted, which leads to the further soft tissue augmentation.

Skeletal Correction: Optimal correction of skeletal malocclusion such as anterior crossbite can be achieved by changing the relationship between the maxilla and mandible with orthognathic surgery or TAD anchorage. Patients often decline orthognathic surgery because of post-operative morbidity and lack of insurance coverage. Extra-alveolar (*E-A*) TAD anchorage is an attractive option for conservative management of skeletal malocclusions.[17] However, patients may decline skeletal correction with either surgery or TADs, and opt for camouflage orthodontics[15] or conservative interdisciplinary treatment.

Orthodontics and Implants: There is a natural interdisciplinary connection between orthodontics and implants, with respect to anchorage and preprosthetic alignment. This link is the underlying premise of the International Association of Orthodontics and Implantology and the current publication International Journal of Orthodontics and Implantology (*IJOI*). Both osseointegrated[18] and nonintegrated[2,4,8,17] fixtures can be used as anchorage to correct malocclusion. On the other hand, orthodontics can be utilized to optimally align the dentition for implants and create implant sites. Depending on the severity of the malocclusion and the location of the edentulous areas, some partially edentulous malocclusions are adequately resolved with orthodontic space closure, but large

Fig. 7:
The maxillary and mandibular midlines are both shifted to the right, suggesting occlusal developmental problems. See text for details.

Fig. 8:
0M: At the start of treatment, an edentulous space is associated with an atrophic concavity (blue arrow) on the buccal surface of the maxillary alveolar process. Note that plaque staining (red) is noted between teeth throughout the mouth.
34M: After mesial translation of the second premolar (#13) to the first premolar position #12, the concavity on the buccal surface of the maxilla is no longer evident (blue arrow).

and asymmetric edentulous spaces usually require implant-supported prosthetics. Patients increasingly regard implants as a desirable alternative to conventional prosthetics, but that option may be more complex and expensive if there is inadequate bone and/or soft tissue at the implant site. Bone grafts are often required to increase the height and width of the ridge. In addition, soft tissue augmentation and sinus lift procedures may be necessary. To avoid misunderstandings, in addition to obtaining a proper informed consent, the pros and cons of all surgical and prosthetic options should be carefully discussed with the patient.

Diagnosis, Etiology and Treatment Planning

A 29-year-old female sought interdisciplinary consultation for a crowded irregular dentition and a protruded chin (*Fig. 1*). The UL2 (#*10*) was a peg-lateral, and there were multiple missing teeth: UL4 (#*12*), UL5 (#*15*), and LL6 (#*19*) (*Figs. 2 and 3*). The upper arch was constricted with a crossbite of the UR incisors (#*7 and 8*) and a midline deviation to the right (*Figs. 5 and 6*). Tipping of adjacent teeth into the extraction site indicated the LL6 was probably lost early as a relatively isolated event (*Fig. 5*).[1,4,5,10,16] Overall, the morphologic pattern was consistent with molar incisor hypoplasia (*MIH*), a common developmental defect in enamel, with a mean prevalence of about 4-20% worldwide; MIH is thought to be associated with high fever at <3yr of age.[20,21,22] Incidence of enamel hypoplasia affecting individual teeth appears to be an endemic problem[22] of long duration because a similar prevalence to modern samples was recently detected in a medieval German population.[23] Defective enamel renders the affected molar highly susceptible to fracture and caries, and it is usually lost before the late transitional stage of dental development (*age 10-12yr*).[1,4,5,10,16,22] It follows that the probable cause of the asymmetric anterior crossbite for the present patient (*Figs. 1-5*) was the lack of a posterior centric stop after the left second deciduous molar was lost, which resulted in occlusal instability.[4,5] In the absence of posterior occlusion, affected children may posture the mandible anteriorly and laterally to achieve more comfortable mastication. Anterior posturing of the mandible may result in a crossbite, and an abnormal occlusal pattern that is manifest as an acquired malocclusion.[1,4,5,12,13]

Maxillary lateral incisors have the second highest incidence of congenital absence in the entire dentition, and they frequently present challenging orthodontic problems. For the current patient, the maxillary midline shifted to the right as space was lost due to a congenitally missing UR2 (#*7*), but it was still coincident with the mandibular midline, because the latter had also shifted to the right. The lower midline deviation was probably due to occlusal instability,[4,5] as previously discussed. Furthermore, TMJ imaging revealed a longer condylar process on the left side (*Figs. 5 and 6*) which is consistent with abnormal mandibular posturing to the right, relative of the facial midline (*Figs. 1 and 7*).

Bimaxillary protrusion was documented in the cephalometric analysis by the increased SNA and SNB angles (*Table 1*). However, lip prominence was only manifest facially as a protrusive mandible (*Fig. 1*), which was probably attributable to the anterior posturing of the mandible into an anterior crossbite. It appears that both chief complaints, irregular teeth and mandibular protrusion, were manifestations of the early loss of the LL6, due to MIH. Thus, the hypothesis for the etiology of the current malocclusion was an aberration in normal development, early loss of a lower first molar, that resulted in an acquired malocclusion. It follows that the treatment plan focused on reversing the etiology, by conservatively correcting the left posterior occlusion and anterior crossbite. Previous experience with MIH-acquired malocclusions in adults revealed that defining the etiology was an important aspect for the diagnosis, because conservative correction of the occlusion tends to recover the normal facial pattern.[1,4,5,10]

Another important aspect for the treatment plan was management of edentulous spaces due to four missing teeth: #7, 12, 15 and 19. Since there is only one molar remaining in the UL quadrant, space closure of the #19 space was the best option, but the roots of the lower left molar had a conical shape with little interradicular space. This root configuration fails to achieve the maximal anchorage[24] that was needed to retract the lower arch. Unfortunately the patient declined the use of TADs so Class III elastics and a root-mesial moment were necessary to supplement the marginal anchorage value of the LL molar. Fig. 9 shows the consequence: excessive mesial root movement of the LL molar (#*18*), resulting from prolonged use of an uprighting moment to achieve maximum retraction.

The missing UL4 space could not be closed because there is only one maxillary molar in the quadrant. However, the atrophic #12 extraction space with a ridge width <4-mm required mesial translation to create a #13 implant site, because the patient declined bone augmentation surgery. So implant placement was indicated with a simultaneous vestibular incision subperiosteal tunnel access (*VISTA*) approach for soft tissue augmentation. This specialized approach required an interdisciplinary

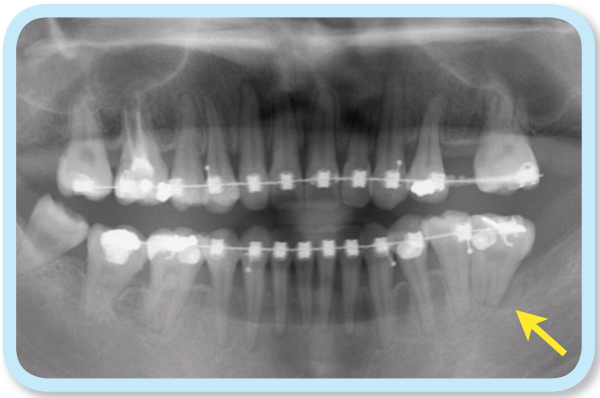


Fig. 9:
During active orthodontic treatment all lower spaces are closed. There was a strain on the anchorage provided by the lower left first molar, as evidenced by mesial tipping to contact the roots of the adjacent second premolar. The implant site on the UL (area #13) was generated by mesial translation of #12. The alveolar bone height in the anterior region is stable compared to the pretreatment radiograph (Fig. 5). Anchorage was strained for the LL molar during space closure (yellow arrow). See text for details.

team skilled in orthodontics, periodontics, and implant-supported prosthetics.

Overview: The American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) for this challenging acquired malocclusion was 27 points, as detailed in the subsequent Worksheet 1. With a carefully sequenced interdisciplinary approach, the severe mutilated malocclusion was corrected to an excellent outcome as evidenced by a Cast-Radiograph Evaluation (*CRE*) of 22 points (*Worksheet 2*). The step-by-step approach to treatment planning and sequencing of interdisciplinary care is illustrated in Figs. 8-25. The final result is shown in Figs. 26-28, and radiographically documented in Fig. 29. Superimposed start and finish cephalometric tracings (*Fig. 30*) show the dentofacial correction, that is detailed in Table 1. Implant site development is illustrated in Fig. 31, and the VISTA soft tissue procedure is shown in Figs. 32 and 33. The long-term stability of the interdisciplinary treatment is documented in Fig. 34.

Treatment Objectives

1. **Periodontal Maintenance**: oral hygiene instruction, thorough periodontal evaluation, and treatment (*as needed*) prior to placing orthodontic appliances; regular periodontal maintenance during and after interdisciplinary treatment.
2. **Minimally Invasive Approach**: full fixed orthodontics therapy for preprosthetic alignment and retraction of both arches; avoid TADs and bone augmentation surgery.
3. **Anterior Crossbite and Mandibular (Md) Midline Deviation**: anterior bite turbos, resilient archwires and intermaxillary elastics to align the arches; correct the intermaxillary relationship and maintain the vertical dimension of occlusion (*VDO*).
4. **Protrusive Lips**: extract the endodontically treated lower second premolar (*#29*) and retract both arches to reduce lip protrusion.
5. **Peg Lateral Incisor**: open space with a coil spring and align #10 for restoration with composite resin (*Fig. 10*).

Fig. 10:
The upper photograph shows the maxillary left peg lateral incisor at the start of the space opening process. The lower view illustrates the peg lateral restoration process. The space was opened, bracket was removed, the tooth was restored to standard dimensions, and then the bracket was rebonded in an ideal position (yellow arrow).

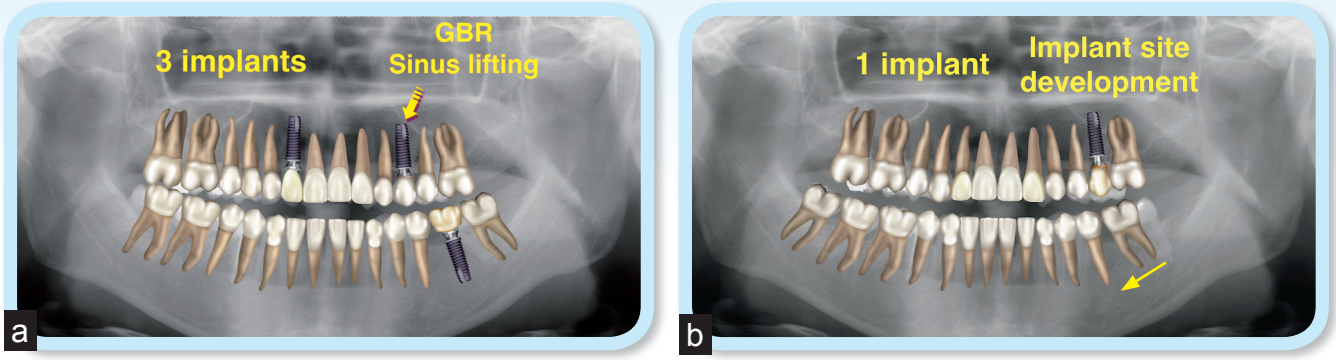


Fig. 11:

a. Treatment Option 1 was opening space, and placing implants to replace the three missing teeth.

b. Treatment Option 2 was extract #29, close space in the lower arch, substitute the UR canine for the missing later incisor, generate an implant site in area of #13, and construct an implant-supported prosthesis.

6. **Canine Substitution**: reshape and restore the UR canine and first premolar for orthodontic substitution to serve as the UR lateral incisor and canine.

7. **Implant Site Development**: Protract the UL4 to create an implant site mesial to the molar (*area #13*).

8. **Soft Tissue Augmentation**: simultaneous connective tissue graft, with a VISTA procedure, at the time of implant placement in the area of #13.

9. **Implant-Supported Prosthesis**: restore the implant with a porcelain fused to metal crown.

10. **Finishing**: orthodontic and soft tissue detailing to enhance facial and dental esthetics.

Treatment Alternatives

The skeletal discrepancy and acquired nature of the malocclusion required at least some orthodontic correction and preprosthetic alignment to achieve an esthetic and stable result. Opening space to restore all the missing teeth (*Fig. 11a*) was rejected because it was an expensive option that failed to address bimaxillary protrusion, midline discrepancy and asymmetric posturing of the mandible. The best option was extraction of the LR5 (*#29*), and then closing space to retract the lower arch to reduce lip protrusion. This approach resulted in only one implant, which did not require bone augmentation, because it was placed in an orthodontically prepared site (*Fig. 11b*). The 3-4-mm right midline deviation of the maxillary arch (*Fig. 12*) was a necessary compromise for opening space to restore the peg lateral, without the use of TAD anchorage. Opening the bite with anterior turbos and intermaxillary elastics provided disclusion for crossbite correction and differential tooth movement to optimally correct dental alignment in the esthetic zone (*Fig. 13*). Implant site development in the upper left quadrant complied with the patient's request for minimally invasive treatment (*Fig. 14*). The limitations

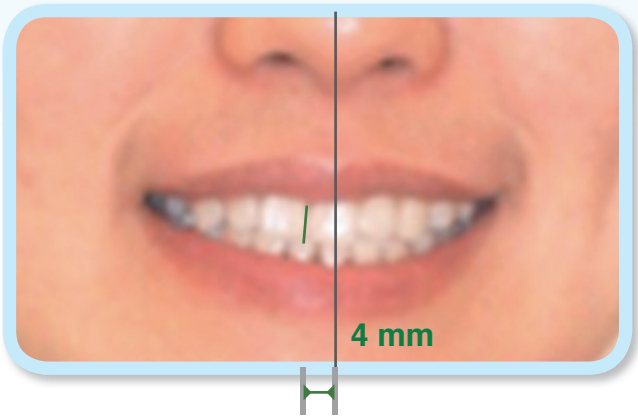


Fig. 12:
The upper midline deviated to the right side about 4-mm when space was opened to restore the UL peg lateral (#10). This problem was avoidable with TAD anchorage that the patient declined. The midline discrepancy was decreased to 3-mm at the end of treatment.

that the patient placed on treatment options, considerably increased treatment time and resulted in a compromised alignment in the esthetic zone, which produced a relatively high Pink and White dental esthetics score of 8.

Treatment Progress

A 0.022-in slot Damon Q® passive self-ligating (*PSL*) fixed appliance (*Ormco, Glendora, California*) was selected and standard torque brackets were used in the anterior segments. All subsequent archwires, coil springs, elastomer chains and latex

Fig. 13:
The UL illustration is the pretreatment view of the right buccal occlusion. The upper center view is the start of active treatment (0M) with anterior bite turbos and early light short elastics (ELSE). At five months (5M) the crossbite is corrected and the occlusion is settling into a near Class I. Twenty-two months into treatment (22M) the lower arch space is closed. At twenty-eight months (28M) treatment is in the finishing stage. The final result is shown at forty-two months (42M).

elastics were supplied by the same manufacturer. The programmed archwire sequence for the upper arch was 0.014-in CuNiTi, 0.014x0.025-in CuNiTi, 0.017x0.025-in TMA, and 0.016x0.025-in SS. The lower archwire sequence was 0.014-in CuNiTi, 0.018-in CuNiTi, 0.014x0.025-in CuNiTi, 0.017x0.025-in TMA, and 0.016x0.025-in SS.

Following extraction of the LR5 (#29), brackets were bonded on all maxillary teeth, except the UR7 (*Fig. 14*). Delaying the bonding of second molars avoids dislodging light wires from the distal tubes during mastication. When the initial maxillary archwire (*0.014" CuNiTi*) was inserted, an open coil spring was placed between the left central incisor and canine (*Figs. 10 and 13*) to increase the mesiodistal width to restore the peg lateral incisor with normal dimensions. Bite turbos were bonded on the lower right central and lateral incisors. The mandibular teeth were bonded two weeks later which was designated as zero months (*0M*) or start of active treatment (*Figs. 13 and 17*). As the anterior cross bite was corrected, early light short Class III elastics (*Quail 3/16" 2-oz*) were applied from the lower canines to upper first molars to retract the mandible and protract the maxilla (*Fig. 13*).

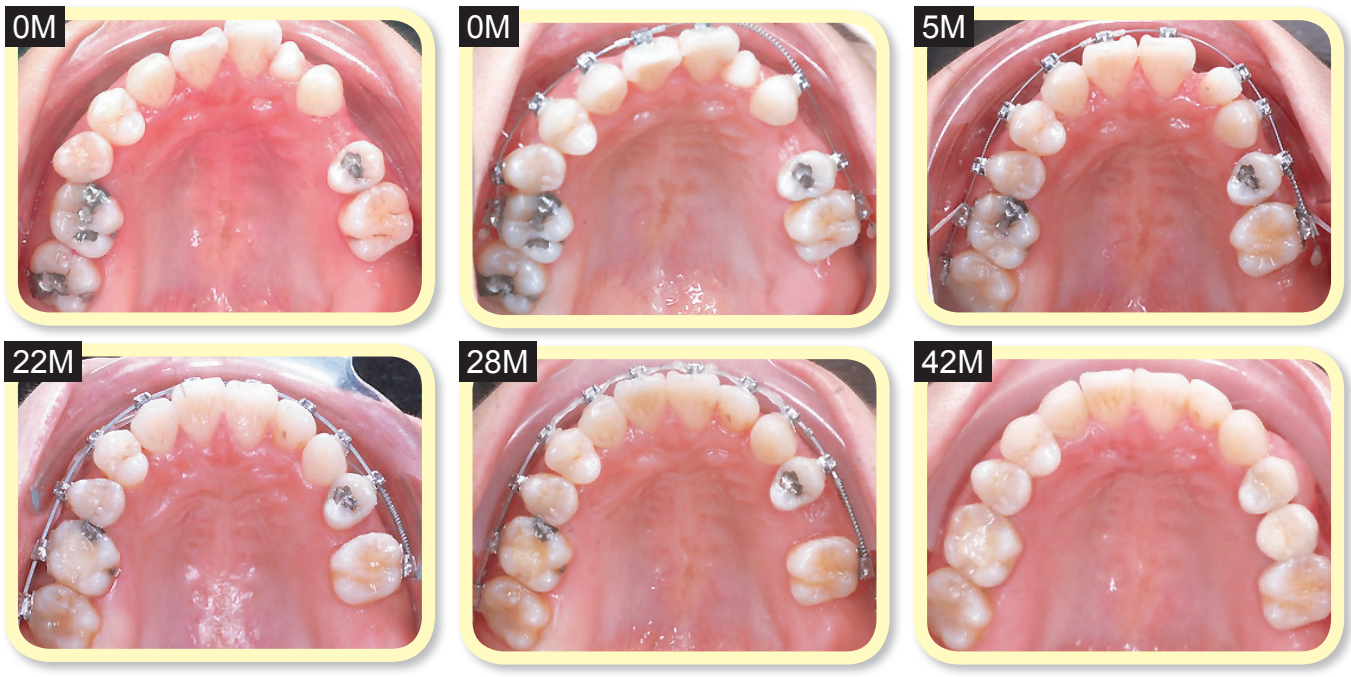


Fig. 14:
As viewed from the upper left to the lower right, the correction of the maxillary arch is shown pretreatment, and at the start of active treatment (0M). Progress is illustrated at five months (5M), twenty-two months (22M), twenty-eight months (28M), and after all the the interdisciplinary procedures were completed (42M). See text for details.

Fig. 15:
Pretreatment (0M) black triangles are prominent in the lower anterior segment. At twenty-two months (22M) the black triangles were reduced by IPR and space closure. The result is further improved at the end of treatment (42M). Overall, IPR was performed six times in the upper anterior segment and three times in the lower anterior segment.

In the 2nd month of treatment, a lingual button was bonded on the palatal surface of the upper left lateral incisor to assist its rotation. Elastomeric modules (*power chains*) were applied between the left lateral incisor and left second premolar.

In the 3rd month of treatment, the upper right second molar was bonded and the upper archwire was changed to 0.014x0.025-in CuNiTi to continue the arch development, as well as to complete the leveling and alignment. An open coil spring was applied between the upper left premolar and molar.

Fig. 16:
An open coil spring was applied for opening space to restore the peg lateral from the beginning of treatment (0M). At nine months (9M) the peg lateral was restored and engaged on the archwire. See text for details.

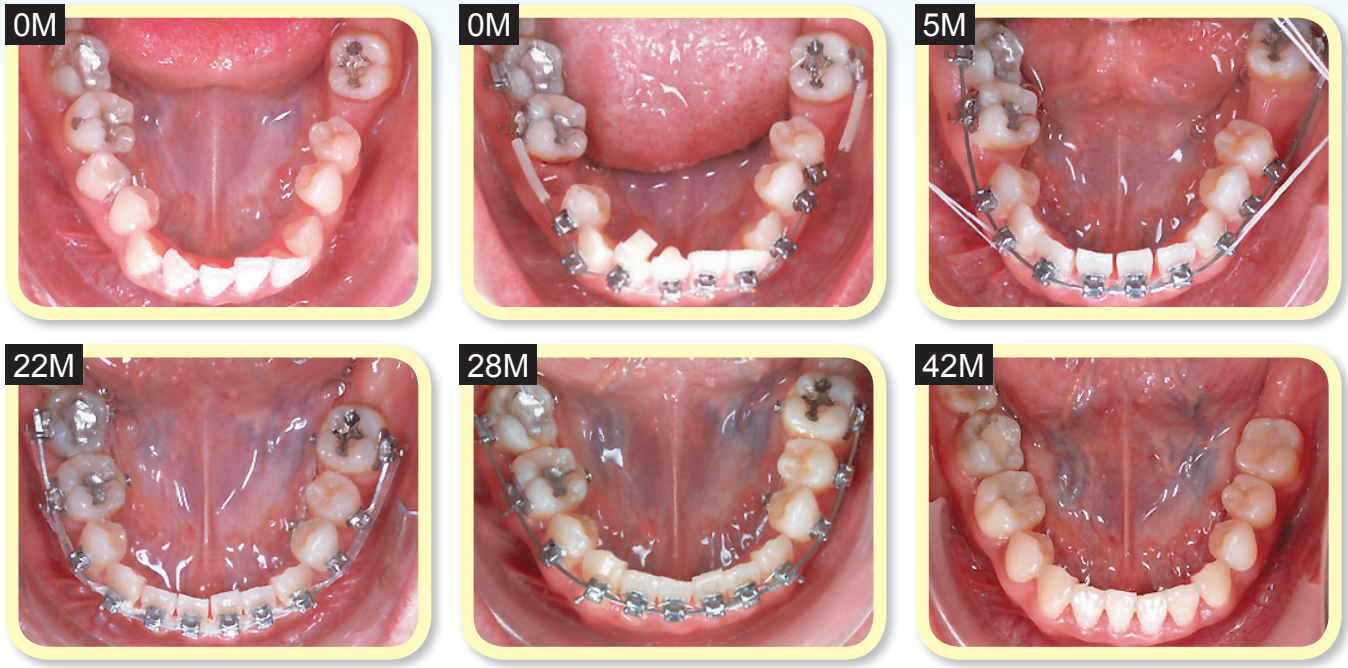
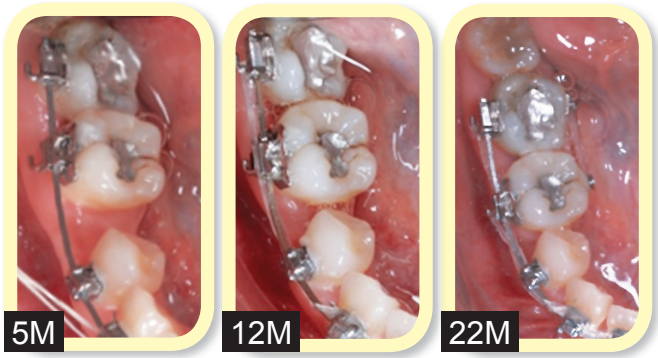


Fig. 17:
From the upper left to the lower right views, the correction of the mandibular arch is shown pretreatment, and at the start of active mechanics (0M). Progress is illustrated at five months (5M), twenty-two months (22M), twenty-eight months (28M), and after treatment was completed (42M). See text for details.

In the 4th month, the button on the upper left lateral incisor was replaced with a standard torque bracket, and a 0.014-in CuNiTi archwire was inserted in the PSL bracket. The lower arch archwire was changed to 0.018-in CuNiTi because the initial 0.014-in CuNiTi wire fractured.

In the 6th month, IPR (*inter-proximal reduction*) of enamel was performed on the lower incisors (*Fig. 17*). The upper and lower archwires were changed to 0.014x0.025-in CuNiTi and 0.017x0.025-in TMA, respectively. An open coil spring was applied between the upper left second premolar and first



0.014x0.025-in CuNiTi | 0.017x0.025-in TMA | 0.016x0.025-in SS

Fig. 18:
Third order correction of the lower right molars and the archwire sequence is shown at five months (5M), twelve months (12M) and twenty-two months (22M). See text for details.

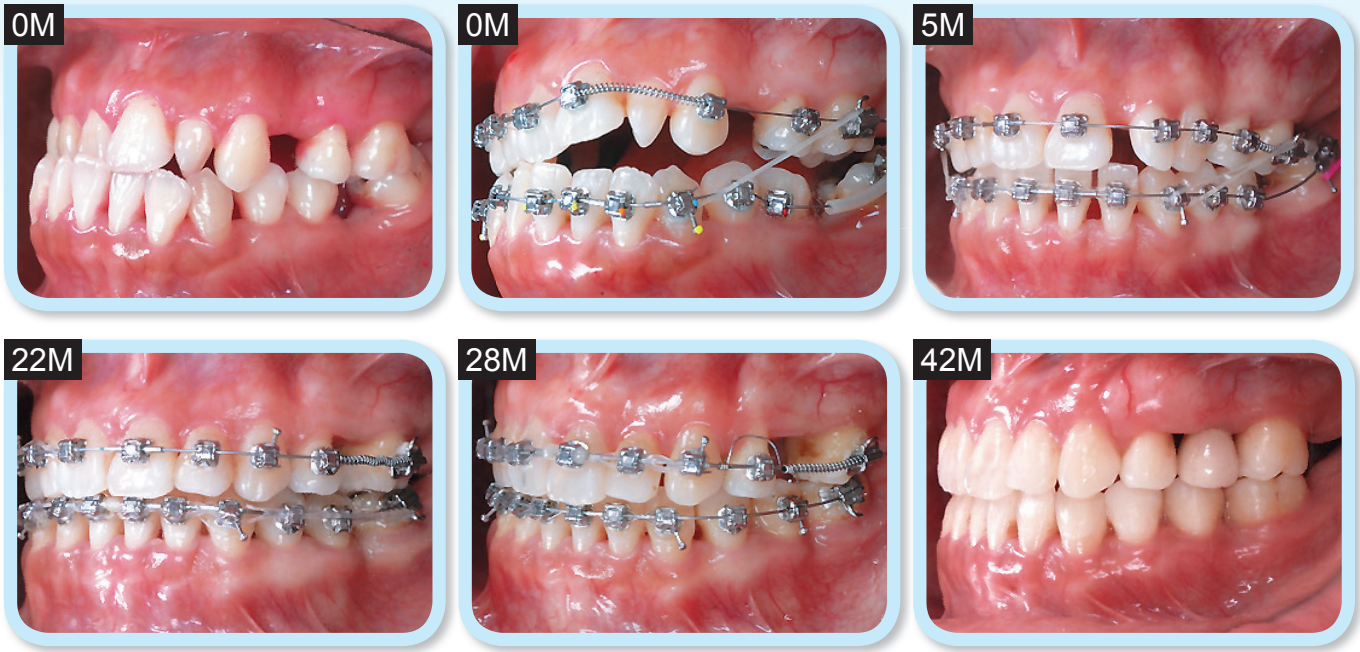


Fig. 19:
Treatment progression on the left side is shown pretreatment (UL), and at the start of active treatment (0M). Progress is illustrated at five months (5M), twenty-two months (22M), twenty-eight (28M), and at the finish which is forty-two months (42M). See text for details.

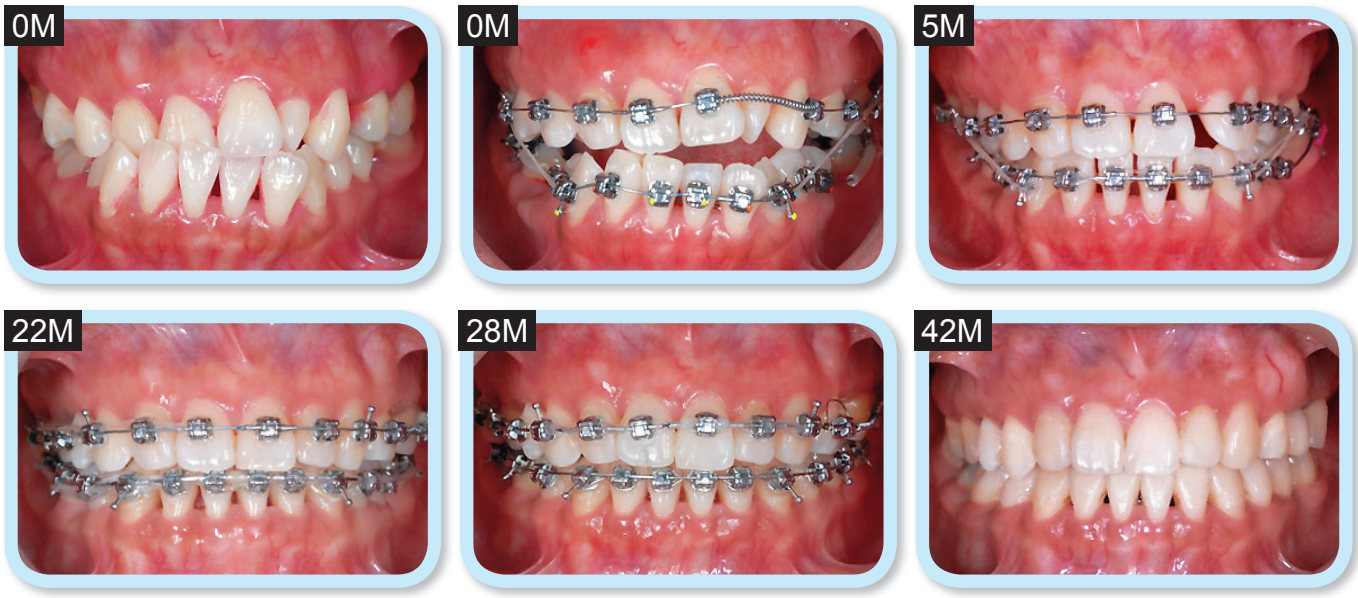


Fig. 20:
Treatment progression in the frontal view is shown pretreatment (UL), and at the start of active treatment (0M). Progress is illustrated at five months (5M), twenty-two months (22M), twenty-eight (28M), and at the finish which is forty-two months (42M). See text for details.

molar to open space for an implant. Bilateral Class III elastics (*Fox 1/4" 3.5-oz*), extended from the upper first molars to the lower canines, were used to resolve the sagittal discrepancy.

In the 8th month, the bracket on the upper left lateral incisor (*#10*) was removed and the tooth was restored to size and shape of the contralateral lateral with light cured resin. Following resin restoration, the bracket was rebonded on the ideal position (*Fig. 10*).

In the 10th month, the archwire was changed to 0.016x0.025-in SS in the upper arch and 0.017x0.025-in TMA in the lower arch. The upper and lower anterior segments (*3-3*) were ligated together with figure-eight ligature ties. The spaces in the lower arch were closed with elastomeric modules (*power chain*) to retract the anterior segment.

In the 12th month, the lower archwire was changed to 0.016x0.025-in SS.

In the 15th month, buttons were bonded on the lingual surfaces of the lower premolars and molars to equally distribute the space closing force on the buccal and lingual surfaces. The space between the UL5 (*#13*) and UL6 (*#14*) was progressively opened to develop an implant site. Full time cross elastics (*chipmunk 1/8", 3.5-oz*) were applied for 6 months to correct lingual inclination of the lower right second molar.

In the 22nd month, IPR was performed on the upper and lower incisors to diminish black triangles. The space generated was closed with an elastomer chain (*Figs. 15, 17, 19, 20*).

In the 24th month, lingual root torque was applied on the lower anterior segment to produce buccal tipping of the lower incisor crowns. L-configuration elastics (*Fox 1/4" 3.5-oz*) were extended from the upper canines to lower molars and passed beneath the hook on the lower canines.

In the 28th month, a torquing auxiliary was applied on the upper left second premolar to provide lingual root torque. Precise bracket repositioning was performed repeatedly throughout active treatment. L-configuration elastics (*Fox 1/4" 3.5-oz*) were also applied from the lower molars to upper canines for 13 months to maintain lower incisor crown torques (*Figs. 13, 17, 19, 20*).

In the 35th month, a pre-operative Cone-Beam Computed Tomography (*CBCT*) scan (*Fig. 21*) was taken to evaluate the alveolar bone volume in the implant site in the area of tooth #13, mesial to the first molar (*#14*). From the slice views, it was noted that sufficient bone volume was available for a 4x9-

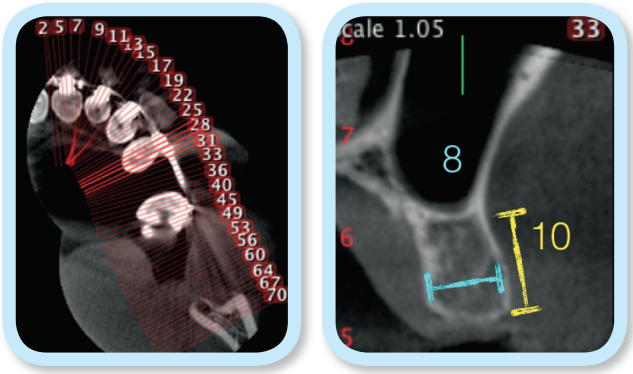
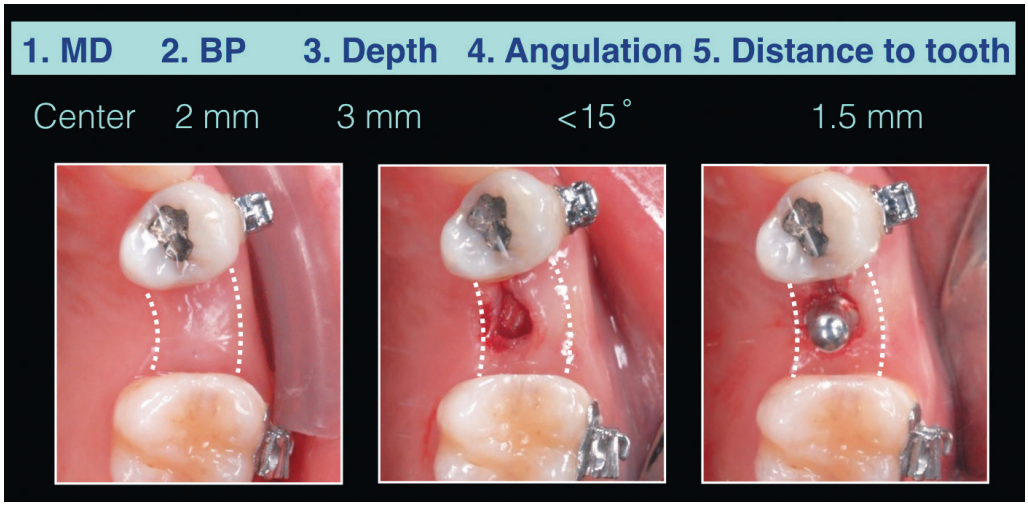


Fig. 21:
A CBCT scan revealed that the edentulous ridge was 8-mm wide and 10-mm high, which was suitable for a 4x9-mm implant fixture. Furthermore, the osseous anatomy was adequate for a flapless implantation procedure.

mm implant (*Fig. 21*). A surgical stent was designed for precise positioning of the implant in three dimensions. The implant fixture was positioned 3-mm below the future crown margin, with a distance of at least 1.5-mm from the adjacent teeth. The 2B-3D rule was followed: 2-mm of bone buccal to the implant, and the occlusal margin of the implant was 3-mm apical to the expected margin for the subsequent crown. This rule is useful for dental implant planning, placement and restoration (*Fig. 22*).

Implant placement procedures

In the 36th month of treatment, the implant procedure is illustrated in Figs. 22 and 23. The orthodontically prepared site (*Fig. 23a*) was opened on the palatal aspect of the ridge (*Fig. 22*) with a trephine bur, that removed a 4-mm diameter plug of soft tissue to expose underlying bone (*Fig. 23b*). After the initial osteotomy with a lancer drill, a guide pin was inserted in the wound (*Fig. 23c*) and a periapical radiograph was exposed to check the parallelism and proximity of the osteotomy to adjacent teeth (*Fig. 23h*). The apical portion of the osteotomy was adjusted ~8° distally according the manufacturer's recommended surgical protocol. According to 2B3D rule (*2-mm of buccal bone and 3-mm apical to desired margin of the future crown*),[14,15] an 4x9-mm Astra OsseoSpeed™ (*Dentsply Implants, Mannheim, Germany*) implant fixture was installed (*Figs. 23d-f*). A flared healing abutment (*4.5-H4*) was screwed into the implant to form the peri-implant mucosal contour. A post-operative periapical radiograph was exposed to check the position and angulation of the implant (*Fig. 23i*).



■ *Fig. 22:*
The fixture position is determined by: 1. Mesiodistal (MD) dimension, 2. Buccal plate (BP) thickness, 3. Depth, 4. Angulation and 5 Distance to the adjacent tooth (teeth). The implant is placed in the center of the MD space, with 2-mm of buccal bone (plate), and 3-mm apical to the subsequent crown margin (2B3D rule). The fixture must be within 15° of an ideal inclination (<15°) and be at least 1.5-mm away from the nearest tooth. See text for details.

Soft tissue grafting with Vestibular Incision Subperiosteal Tunnel Access technique

The soft tissue augmentation with a connective tissue graft (*CTG*) is illustrated in Fig. 24. Immediately following the surgical implantation procedure (*Fig. 24a*), a CTG was performed with the VISTA technique (*Fig. 24b-i*). A 15-mm vertical incision was made through the periosteum mesial to the canine, and a subperiosteal tunnel was elevated with VISTA-2 elevator (*Dowell Dental Products, Cucamunga, California*) (*Fig. 24b*). This subperiosteal tunnel was extended interproximally under the papilla without making any additional incisions. A slight perforation occurred in the alveolar mucosa over the left canine eminence (*Figs. 24b-c*). The root surface of tooth #13, previously moved to the position of #12, was carefully prepared with a round diamond bur: overhanging composite resin was removed and a

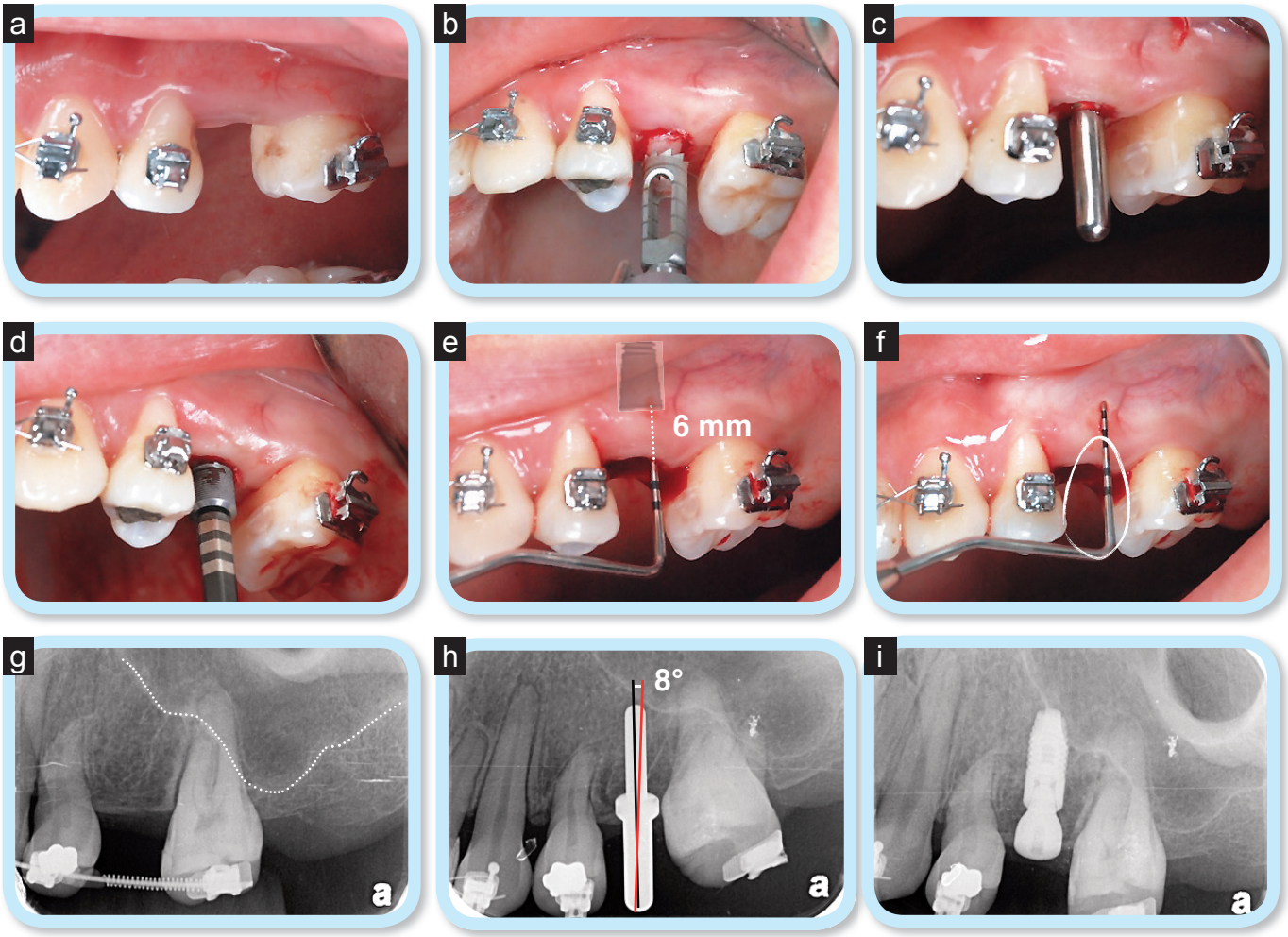


Fig. 23:
The clinical procedures and measurements for implant placement: a. pre-operative view, b. soft tissue trephine, c. guide pin, d. implant insertion, e. implant depth measurement (6-mm to the fixture platform), f. width of attached gingiva, g. Mx sinus floor evaluation, h. axial inclination adjustment of 8°, and i. installed fixture. See text for details.

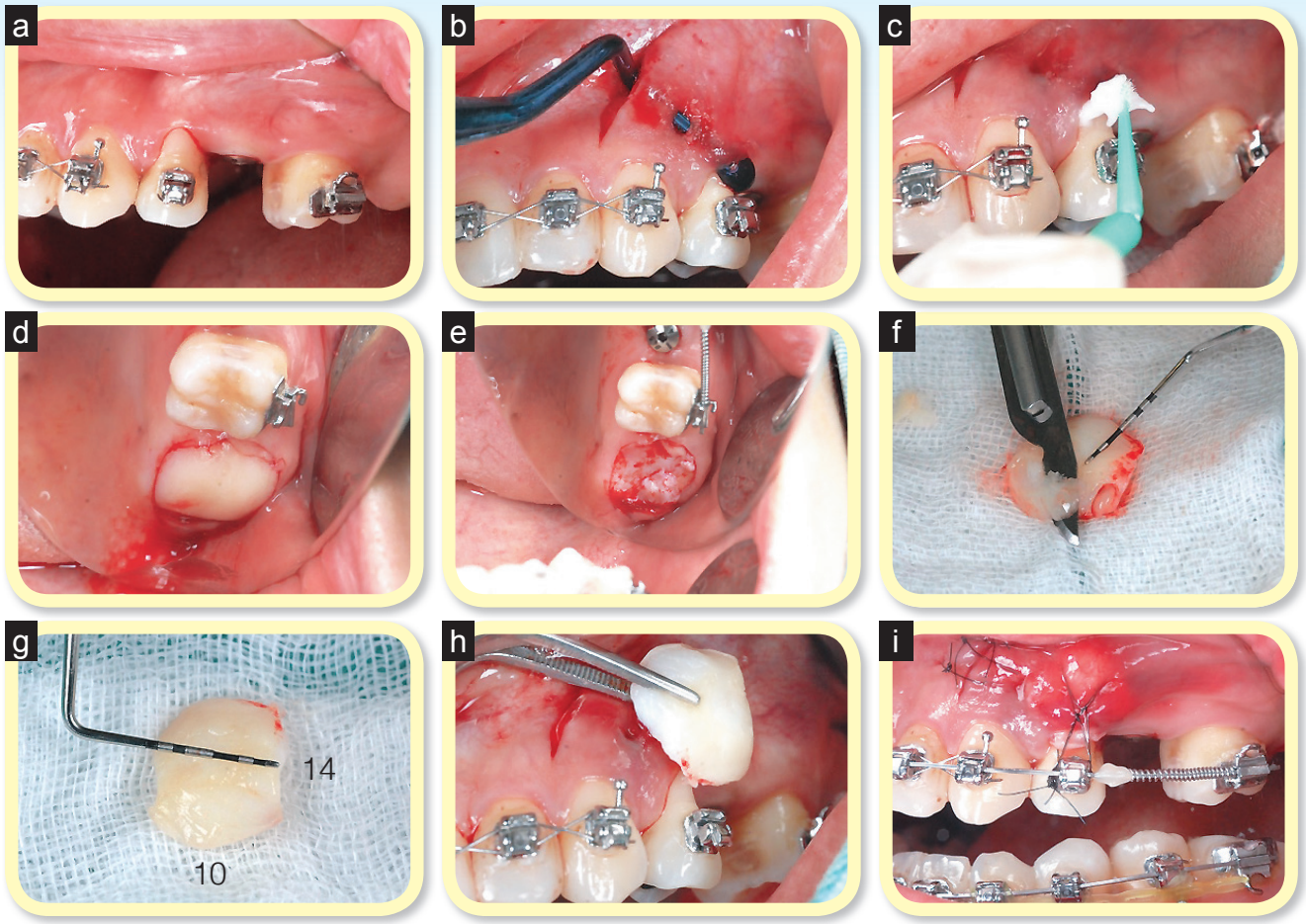


Fig. 24:
Soft tissue grafting with the VISTA technique is illustrated with a series of photographs: a. pre-operative view, b. tunneling through the vertical incision, c. preparation of the root surface, d. soft tissue incision of donor site, e. donor site after the gingival specimen was removed, f. epithelium is removed from the connective tissue, g. prepared graft, h. fitting the graft the recipient site, and i. completed connective tissue grafting procedure. See text for details.

slight concavity was formed in the cervical area to receive the soft tissue graft. The site was throughly prepared with curettage and de-contamination. Root conditioning was performed with ethylenediamine-tetraacetic acid (*EDTA*) gel for 30 seconds (*Fig. 24c*). A 14x10-mm soft tissue graft (*Fig. 24d*) was harvested from the upper right tuberosity with a No. 15c blade (*Fig. 24e*). The epithelium was carefully removed with a new sterile No. 15c blade to prevent epithelium entrapment under the connective tissue (*Fig. 24f*). The CTG (*Fig. 24h*) was inserted through the tunnel and positioned over the cervical root area of #13. Then the graft and flap margin were advanced coronally and stabilized in the desired position (*Fig. 24i*). The vertical incision was closed and sutured. A coronally advanced suture (*4-0 nylon*) was secured to the facial aspect of #13 with bracket and reinforced with light cured composite resin, to prevent apical relapse of the gingival margin during healing. The sutures around the vertical incision were removed 1

week later, and the coronally anchored sutures were removed at the 3-week postoperative evaluation.

After 41 months of active treatment, all appliances were removed. Upper and lower clear overlay retainers were delivered for both arches.

Implant Prosthesis Fabrication

Six months after the implant placement (*Fig. 25a*), the healing abutment was removed (*Fig. 25b*), and a direct abutment (*5x4-mm, 3.5/4.0*) was selected for prosthesis fabrication (*Fig. 25c*). Before taking the impression, the abutment was torqued twice to 25-35 N-cm with a torque wrench (*25e*). The screw access hole for the abutment was then sealed with a small cotton pledget and temporary cement. For the abutment level impression, the surface of the abutment was aligned with the raised knob on the Impression Pick-up and it was firmly snapped it into

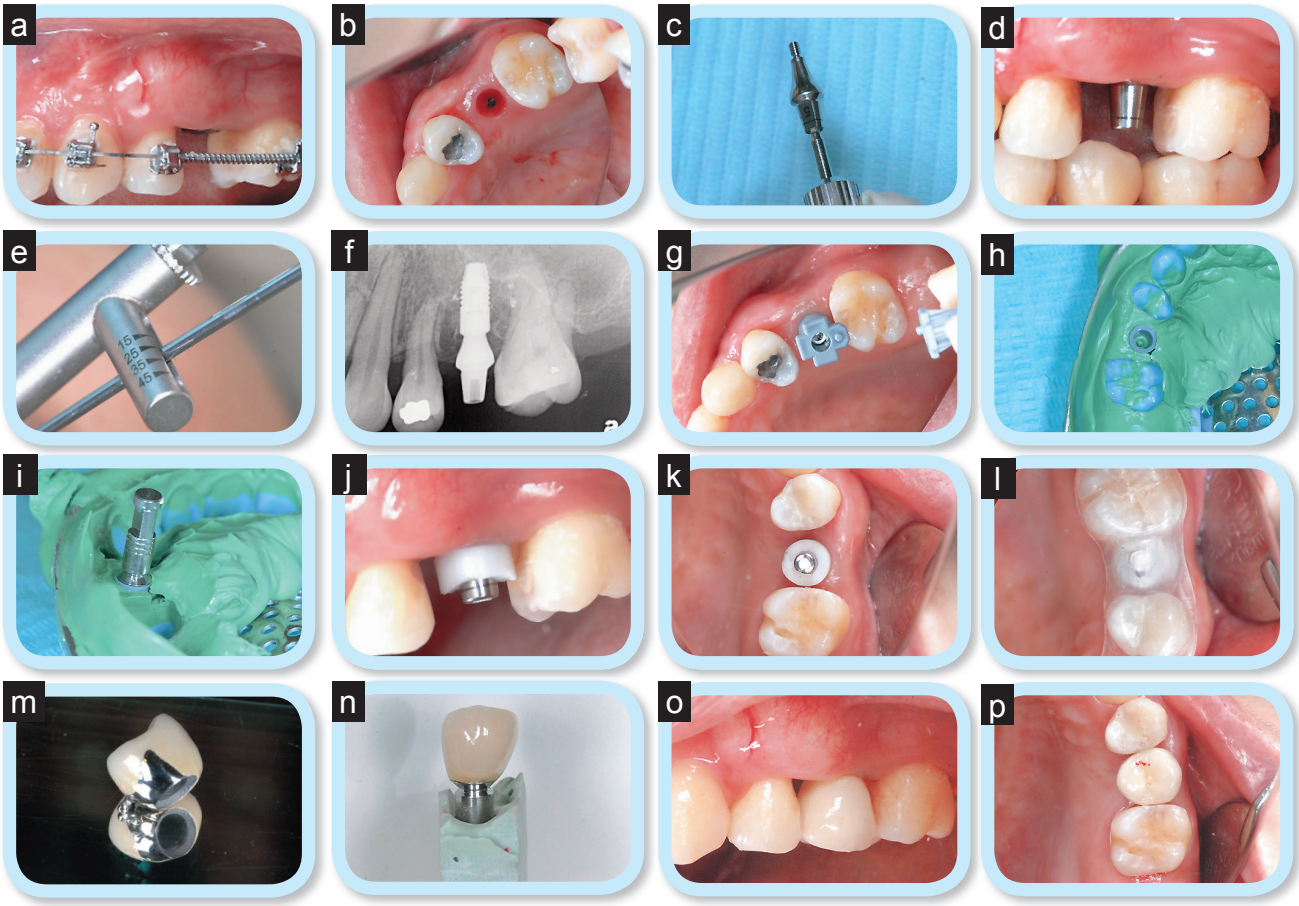


Fig. 25:
The implant prosthesis fabrication is illustrated as follows: a. buccal view of the site for the implant-supported crown, b. occlusal view of the site in area of tooth #13, c. abutment ready to insert, d. abutment seated on the implant, e. torque wrench, f. implant with abutment after being torqued to place, g. impression pick-up seated on the abutment, h. impression with the embedded pick-up, i. analogue seated in the pick-up, j. lateral view of the Tony cap fitted in the implant to form and control soft tissue, k. occlusal view of the Tony cap, l. overlay retainer seated over the Tony cap, m. fabricated porcelain fused to metal crown lying on a reflecting surface, n. crown fitted on the abutment, o. buccal view of the final implant-supported crown, and p. occlusal view of the crown restoring tooth #13.

CEPHALOMETRIC			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA° (82°)	86˚	86˚	0˚
SNB° (80°)	85˚	85˚	0˚
ANB° (2°)	1˚	1˚	0˚
SN-MP° (32°)	38˚	35˚	3˚
FMA° (25°)	31˚	28˚	3˚
DENTAL ANALYSIS			
U1 TO NA mm *(4 mm)*	6 mm	3 mm	3mm
U1 TO SN° (104°)	105.5˚	108˚	2.5˚
L1 TO NB mm *(4 mm)*	9 mm	2 mm	7mm
L1 TO MP° (90°)	83˚	68˚	15˚
FACIAL ANALYSIS			
E-LINE UL *(-1 mm)*	-2 mm	-2 mm	0 mm
E-LINE LL *(0 mm)*	3 mm	-1 mm	4 mm

■ Table 1: Pre-Tx and Post-Tx Cephalometric Analysis Summary

place (*Fig. 25g*). A closed tray impression technique was used. Polyvinyl siloxane material was injected to make the impression (*Fig. 25h*). The impression was checked and the analogue was inserted (*Fig. 25i*).

The height of the abutments must not infringe on the 2-mm of occlusal clearance required for the fabrication of a porcelain fused to metal crown (*Fig. 25d*). After checking the occlusal clearance, the abutment was cemented with Tony caps (*Alliance Global Technology, Kaohsiung City, Taiwan*) to prevent soft tissue overgrowth (*Fig. 25j-k*). A clear retainer was also delivered to maintain the position of adjacent teeth (*Fig. 25l*). The permanent crown was constructed (*Fig. 25m-n*) and fitted to the abutment intraorally (*Fig. 25o-p*). Gingival margin integrity was verified with a dental explorer, and the appropriate tightness of the contact area was confirmed with dental floss. After radiographic verification of the abutment fit, the permanent crown was luted to place with permanent cement.

Treatment Results

The patient was treated to the desired result as documented in Figs. 26-28. The cephalometric and panoramic radiographs before and after treatment are shown in Figs. 5 and 29, respectively. Before and after treatment cephalometric tracings were superimposed in Fig. 30. The summary of cephalometric measurements is provided in Table 1.

The protruded lower lip was retracted 4-mm by closing the bilateral extraction spaces. The significantly decreased L1-MP angle indicates that the lower incisors were tipped lingually. For Tweed's diagnostic triangle, a 90 degree of L1-MP angle was the key to achieving optimum stability.[25] If the L1-MP angle for the current patient were treated to 90 degrees, the chin would be even more protrusive. The Tweed standard could only be achieved with orthognathic surgery. Conservative treatment required lingually tipped lower incisors (*Fig. 30*).

The American Board of Orthodontics (*ABO*) Cast-Radiograph Evaluation (*CRE*) was 22 points (*Worksheet 2*), as documented later in this report. The major discrepancy was 5 points scored for occlusal relationships, and 4 points were scored for buccolingual inclination. The latter primarily involved the lingually inclined lower right molars. All extraction spaces were closed.

The Pink & White dental esthetic score was 8

Fig. 26:
Post-treatment facial photographs show acceptable symmetry, markedly improved (straight) profile, and pleasing smile line.

Fig. 27:
Post-treatment intra-oral photographs reveal an asymmetric upper arch with a 3-mm midline deviation. The mandibular midline was within normal limits after the crossbite was corrected. Upper and lower occlusal archforms are near ideal.

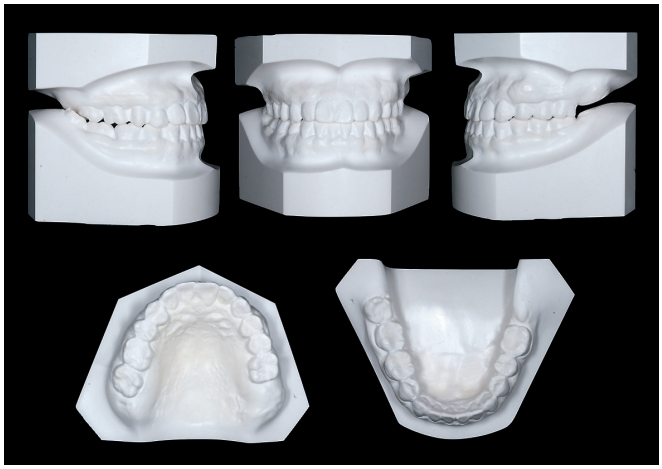


Fig. 28:
Post-treatment white stone models (casts) show the final alignment that is scored for a CRE of 22 points. See Worksheet 2 for details.

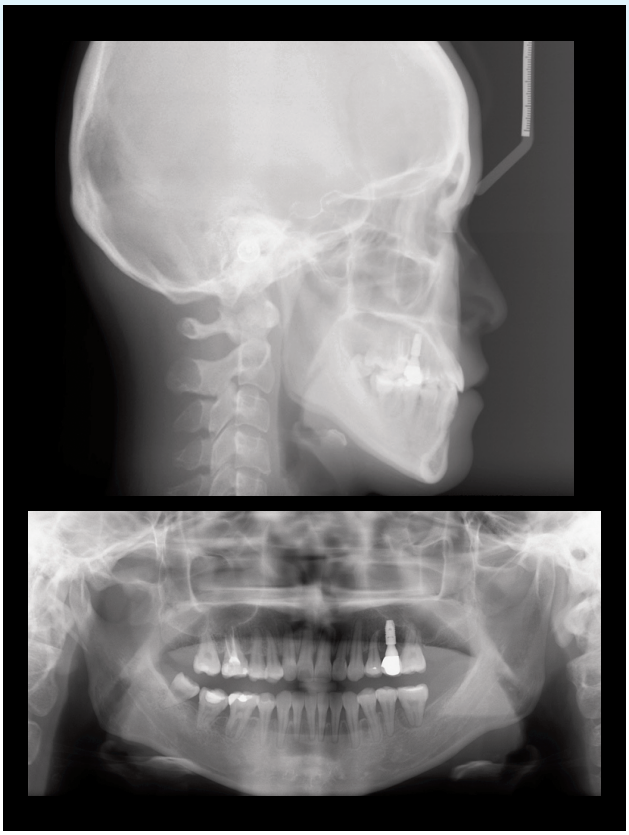


Fig. 29:
Post-treatment cephalometric and panoramic radiographs document the final outcomes for the interdisciplinary treatment.

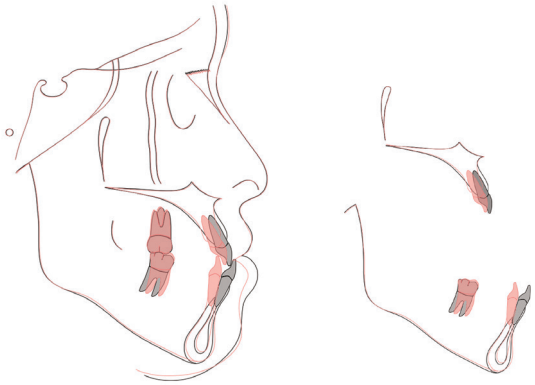


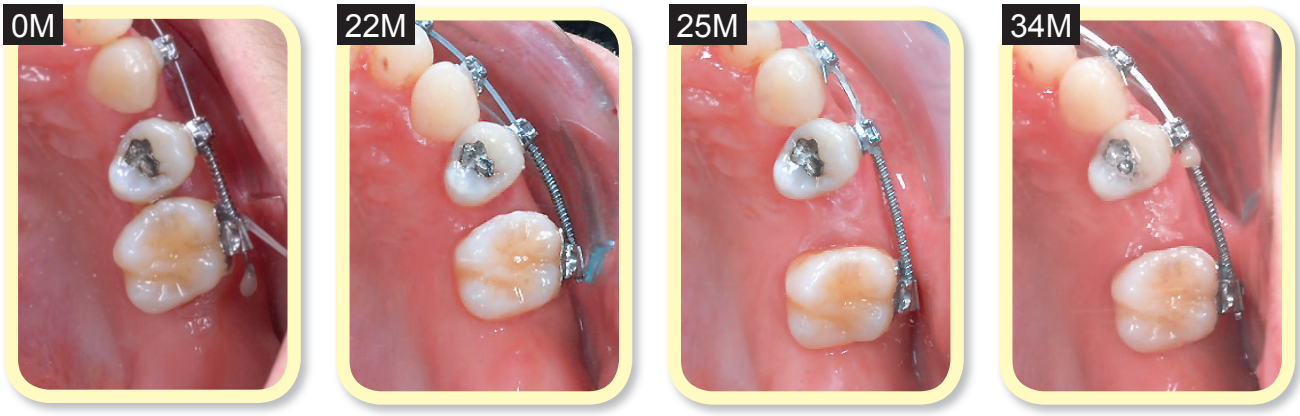
Fig. 30:
Cephalometric tracings document the dental and skeletal changes during treatment. The pretreatment (blue) and post-treatment (red) tracings are superimposed on the anterior cranial base (left), as well as on the stable skeletal landmarks of the maxilla (upper right), and mandible (lower right).

points (*Worksheet 3*), as documented on the form appearing later in this report. The major discrepancy was the white esthetic score (*6 points*) because of restorative problems in managing the upper left peg lateral and congenitally missing right lateral incisor. The major compromise was the positioning and spacing of teeth in the maxillary anterior segment which resulted a midline deviation of about 3-mm to the right. Esthetic composite resin restorations were performed for the left lateral incisor and the right canine-premolar substitution, but it was still very challenging to compensate for the compromised alignment. The esthetic zone problems were preventable with TAD anchorage, but the patient preferred the esthetic compromises rather than agree to the use miniscrew anchorage.

The UL implant-supported prosthesis was a near ideal restorative procedure. The implant was correctly positioned and angulated, but the mesial and distal papillae were blunted. There was no impact on esthetics while smiling (*Figs. 26 and 27*), but open interproximal spaces tend to trap food so they can be a hygiene problem.

Overall, post-treatment radiographs (*Fig. 29*) document near ideal facial form, well aligned dentition, ideally positioned implant-supported prosthesis, and stable alveolar bone height. Both dental arches were retracted to correct lip protrusion (*Fig. 30*). Extraction spaces were closed and the maxillary arch was expanded with a minimally invasive approach to correct the crossbite (*Figs. 27 and 28*). Overall, the treatment outcomes were an excellent conservative result, considering the restriction on the use of orthognathic surgery and TADs. The patient was quite satisfied with the result.

Figs. 13, 14, 16, and 17-20 are intraoral photographs documenting the orthodontic treatment sequence. Despite the asymmetric length of the mandibular condyles, due to the acquired malocclusion (*Fig. 6*), unlocking the occlusion with anterior bite



■ *Fig. 31:*
Sequential occlusal views of implant site development are show from the start of space opening (0M) to thirty-four months (34M). Conservative orthodontic implant site development in the area of #13 required 29 months. This relatively slow rate of tooth movement was associated with increased bone height and width of the ridge, and also resulted in increased attached gingiva. See text for details.

turbos permitted crossbite correction with routine archwire alignment of the upper arch. Restoring a normal pattern of occlusal function resulted in improved mandibular symmetry (*Fig. 26*). No significant tempo-mandibular disorder was noted before, during or after treatment. These data indicate that the TMJ has a remarkable ability to adapt to functional occlusion.

Orthodontic implant site development is longitudinally documented in Fig. 31. Fig. 32 illustrates the VISTA surgical sequence that is recommended for orthodontically generated sites. Fig. 33 is a VISTA alternative for atrophic implant sites that are not prepared orthodontically.

Upper and lower clear overlay retainers were delivered. The patient was instructed to wear them full time for the first 6 months and then nights only. Home care and retainer maintenance instructions were also provided. The patient returned for one-year follow-up evaluation. All of the treatment results were stable, and the mandibular asymmetry continued to improve (*Fig. 34*).

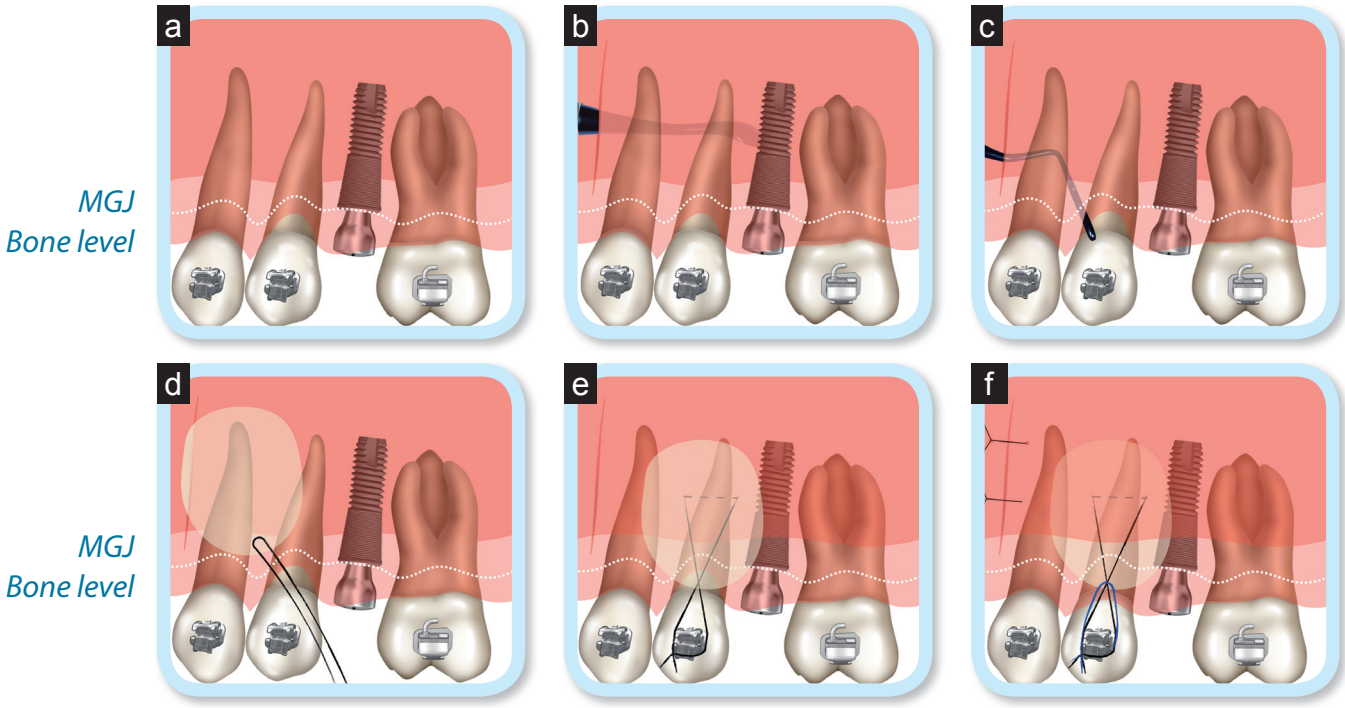


Fig. 32: CTG in an Orthodontically Generated Implant Site.
Assuming adequate hard and soft tissue was produced in the implant site, the connective tissue grafting (CTG) procedure via VISTA access is shown for augmenting the periodontium of a tooth adjacent to the implant: a. After implant site development, 2-mm of gingival recession was noted on tooth #13, that was moved to the #12 position, b. A 5-mm vertical incision and subperiosteal tunnel was created with Vista 1 periosteal elevator, c. The tunnel was coronally advanced to the gingival margin of tooth #13 with a Vista 3 periosteal elevator, d. A lasso silk suture was used to guild the tuberosity CTG through the vertical incision and into the subperiosteal tunnel, e. A horizontal mattress suture was secured to the crown of the tooth to immobilize the tuberosity graft, f. The buccal flap of mucosa was coronally advanced 2-mm occlusal to the cementoenamel junction (CEJ) level, and the modified horizontal mattress suture was wrapped and tied around the bracket. See text for details.

The Discrepancy Index (*DI*) scoring method is explained in Worksheet 1. The Cast Radiograph Evaluation (*CRE*) is detailed in Worksheet 2. Pink and White dental esthetic score was 8 because of the compromised management of the peg lateral incisor (*Worksheet 3*). Implant-Abutment Transition & Position Analysis was an ideal zero (*Worksheet 4*). All of the outcomes worksheets are at the end of this report.

Overall, the patient was very pleased with the interdisciplinary treatment delivered. The pattern of skeletal and dental compensation necessary to conservatively manage this severe malocclusion with a DI=27 is revealed in the cephalometrics. The balanced maxillary protrusion (*ANB 1°*) is less noticeable due to an increased lower facial height associated with an increased mandibular plane angle (*FMA 28°*) and lingually inclined lower incisors (*L1 to MP 83°*).

Discussion

The goal for restoring missing teeth is to collectively

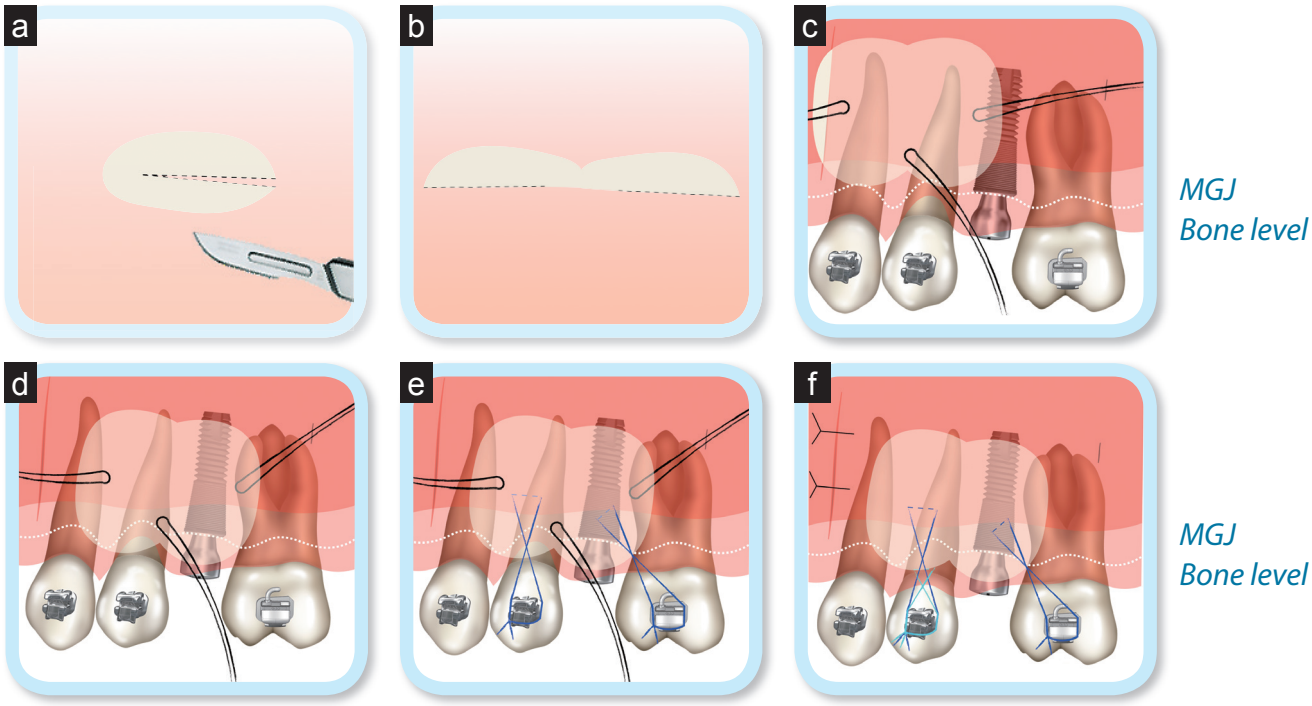


Fig. 33: CTG for an Implant and an Adjacent Tooth.
If the implant site development was not performed and buccal soft tissue is inadequate over both tooth #13 and implant fixture, the VISTA technique should be modified: a. The thick tuberosity graft is partially sliced, b. The graft is unfolded to increase its length (not to scale), c. The unfolded graft is inserted through the vertical incision into the subperiosteal tunnel with guiding lasso sutures, d. The CTG is positioned on the buccal surface of the implant and the adjacent tooth with gingival recession (#13), e. The two halves of the unfolded tuberosity graft are immobilized with separate modified horizontal mattress sutures secured with the brackets on the teeth adjacent to the implant, f. The gingival margin of tooth #13 is coronally advanced to 2-mm occlusal to the CEJ with another modified horizontal mattress suture secured to the bracket. See text for details.

achieve normal function, comfort, esthetics, speech, and longterm health. Congenitally missing permanent maxillary lateral incisors are a substantial challenge for achieving an esthetic outcome. The usual treatment options are opening the space and restoring the missing tooth with an implant-supported prosthesis, or moving the entire buccal segment mesially to substitute the adjacent canine for the missing lateral. Patients and clinicians often prefer the space closure option because they deem it a more conservative and desirable treatment plan compared to implants and prostheses.[26-28] The specific criteria for canine substitution were reviewed by Kokich and Kinser.[29] In addition to periodontal health, there are a number of important considerations when considering dental substitution: facial profile, type of malocclusion, space conditions, morphology and shades of the crowns, length of roots and gingival contours.[29,30]

Fig. 34: One year follow-up records.
The stability of the dentofacial outcomes is documented. Despite the lingually inclined lower incisors (decreased L1-MP angle), the occlusal correction is stable. Note that the mandibular deviation continued to improve with a normal pattern of masticatory function.

For the present patient (*Figs. 1-3 and 5*), the convex facial profile and space conditions favored the canine substitution. Because #12 was extracted years previously, the edentulous alveolar ridge was atrophic. The literature documents that alveolar ridge atrophy rapidly progresses for 6 months after the extraction, resulting in a loss of horizontal ridge width to a mean of 3.8-mm, coupled with a mean vertical reduction in ridge height of 1.24-mm.[31] Ridge preservation following extraction can maintain the volume and height of the edentulous ridges.[32,33] However, patients rarely benefit from this procedure because they deem it as expensive and unnecessary. Thus, most patients require bone augmentation with guided bone regeneration before placing an implant.

Implant site development

Instead of guided bone regeneration, an implant site development was performed by translating tooth #13 through the edentulous site where #12 was extracted. As expected there was an increase in attached gingiva, bone height and ridge width at 34 months into active treatment (*Fig. 31*).

Theoretically, implant site development[34] can be accomplished in any portion of the alveolar ridge

where an implant is to be placed.[35] The regenerated bone width is directly related to the buccal-lingual dimension of the tooth moved through the defect.[34] The bone created by moving a tooth through an edentulous site in the maxilla is relatively stable and the post-treatment reduction of the alveolar width is relatively small. Novckova et al.[36] noted that the loss of bone mass, in sites orthodontically prepared for implants to restore missing lateral incisors, was less than 1% up to 4 years after treatment. The reduction of the alveolar ridge width was less than 2% up to 5 years after treatment.[36]

The previous studies were performed for edentulous areas in the maxilla, predominately the lateral incisor area. A subsequent study evaluated ten orthodontically generated edentulous areas in the premolar areas of the maxilla and mandible.[37] Only three of the ten orthodontically generated sites received an implant; two were in the maxilla and one was in the mandible. Following orthodontic development of an edentulous ridge, a decreased width was noted for a newly established edentulous area, but the width increased for the ridge into which the tooth was moved.[37] These data are difficult to interpret because of the variability in maxillary and mandibular premolars, and how the edentulous areas were subsequently treated: fixed bridge, space closure, or implant. However, a consistent finding in the study was that teeth moved into an alveolar defect showed lateral root resorption on the pressure side at the level of the atrophic bone crest. The area of lateral root resorption tended to repair at 1-year follow-up.[37]

Root coverage procedure

Gingival recession defects[38] in conjunction with orthodontic tooth movement are a concern when a tooth is moved outside of the process of alveolar bone. Furthermore, there is a relationship between the development of soft tissue recession, thin gingival biotype, pre-treatment presence of recession, and/or gingival inflammation.[38]

Following implantation, a soft tissue graft with the VISTA technique enhanced the long term esthetic results for the implant prostheses and the adjacent teeth. There are several systematic reviews which have identified advantages for autogenous subepthelial CTGs relative to root coverage and increased width of keratinized tissue.[38,39] In these reviews, the CTG was often superior to guided tissue regeneration and allografts for at least some aspects gingival recession treatment. Additional studies examining longterm results of the CTG appear to further support long-term efficacy for maintaining root coverage.[40]

Root coverage procedures require donor tissue harvesting, tunnel preparation in the recipient site and a coronally advanced flap.[41] The conventional tunnel preparation primarily uses an intrasulcular approach to create either a sub- or supraperiosteal space to extend beyond the mucogingival junction, allowing graft tissue to be inserted under the gingival collar. Intrasulcular tunneling is technically challenging because of the need to obtain access through a small sulcular access point. The increased

risk of traumatizing and perforating the mucosa may result in unfavorable healing outcomes. As a consequence of these limitations, the vestibular incision subperiosteal tunnel access (*VISTA*) approach was developed to avoid complications with the intrasulcular tunneling method.[40]

VISTA sequence

Initial preparation of recipient teeth includes thorough scaling and root planing, as well as odontoplasty to reduce any cervical prominence of roots that extend beyond the confines of the alveolar housing. Odontoplasty is performed using rotary finishing burs or ultrasonics with diamond-coated inserts. The roots are then conditioned for 2 minutes with 24% buffered EDTA gel to eliminate the smear layer. As illustrated in Fig. 32, the VISTA approach begins with a vertical access incision, depending on the sites being treated. The incision is made through the periosteum to elevate a subperiosteal tunnel, exposing the facial osseous plate as well as root dehiscences. This tunnel is extended at least one or two teeth beyond the tooth requiring root coverage, and the gingival margins are mobilized to facilitate coronal repositioning. The VISTA periosteal elevator (*VISTA 1, same manufacturer*) is introduced through the vestibular access incision and inserted between the periosteum and bone to elevate the periosteum, creating a subperiosteal tunnel. It is important to extend the tunnel elevation sufficiently beyond the mucogingival junction as well as through the gingival sulci of the teeth being augmented to allow for low-tension coronal repositioning of the gingiva. Use of an elevator with bayonet curves (*VISTA 2 and 3 from the same manufacturer*) facilitates access to the gingival sulcus and interproximal areas from the vertical incision. No surface incisions through the papillae should be made.

A fine-tipped curved serrated forceps may be used to insert the tuberosity graft inside the subperioteal tunnel. Alternatively, the graft may be guided using a lasso suture within the tunnel by inserting a 4.0 silk suture with a 22-mm 3/8 circle needle subperiosteally within the gingival sulcus of the most distal tooth and exiting through the midline access incision. The suture is then passed through the edge of the graft and returned through the same path of entry to exit from the distal tooth sulcus. Once the graft has been properly positioned, a horizontal mattress suture is applied to fix the relative position of the CTG and the buccal flap. Then the silk suture is removed and the graft is carefully repositioned below the gingival margin of the augmented tooth. The graft and flap are coronally advanced and anchored to the bracket with another horizontal mattress suture (*blue line*) (*Fig. 32f*). The VISTA sequence for orthodontically generated sites is summarized in Fig. 32, and a variation of the method is shown for sites there were not prepared with orthodontics (*Fig. 33*)

According to Prato et al.[41] 100% root coverage can be anticipated if the gingival margin is repositioned more than 2-mm coronally to the CEJ. If excessive

tension is detected during coronal repositioning, the subperiosteal tunnel is further elevated in all directions or additional sutures must be placed. The vertical incision is then approximated and sutured primarily, with multiple interrupted sutures. Sutures at the access incision may be removed after 1 week, but coronally anchored sutures are maintained until the 3-week postoperative visit. The extended period of gingival margin immobilization is required until the gingival margin is sufficiently healed to maintain the desired position.

The most commonly adopted surgeries for root coverage include the coronally advanced flap (*CAF*), intrasulcular tunneling techinque (*IST*) and subperiostral tunnel access (*VISTA*).[40] Sato[42] conducted a retrospective research comparing the efficacy of these three modalities (*CAF, IST, and VISTA*) for treating gingival recession defects. The mean root coverage achieved was 66% for IST (*median 67.4%*), 90.1% (*median 100%*) for VISTA, and 72.9% for CAF. Thus, VISTA was found to be the most effective intervention modality, especially in challenging situations with severe gingival defects (*Miller class III*).[42]

Conclusion

When treating adults, the importance of interdisciplinary treatment cannot be overemphasized. Orthodontics may be necessary for preprosthetic alignment, but soft tissue augmentation and implantation are also required for managing multiple missing teeth. Without orthognathic surgery and miniscrews, facial esthetics were markedly improved by retracting the mandibular arch, but there was a compromise in the maxillary dental midline, because TADS were not used. Implantation and soft tissue grafting (*VISTA technique*) were successfully performed in a single surgery. Orthodontic implant site development precluded the need for bone grafting and a sinus lift procedure. Patients prefer minimally invasive treatment and this approach will undoubtedly increase in popularity.

Acknowledgment

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 27

OVERJET

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

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

Total = 11

OVERBITE

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

Total = 0

ANTERIOR OPEN BITE

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

Total = 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 = 2

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 = 4

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° 0 = 0 4 pts.

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

Each degree > 6° _____ x 1 pt. = _____

SN-MP

≥ 38° = (2 pts.)

Each degree > 38° 1 x 2 pts. = 2

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

Each degree > 99° _____ x 1 pt. = 0

Total = 4

OTHER (See Instructions)

Supernumerary teeth	_____ x 1 pt. =	_____
Ankylosis of perm. teeth	_____ x 2 pts. =	_____
Anomalous morphology	1 x 2 pts. =	2
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	1 x 2 pts. =	2
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 = 6

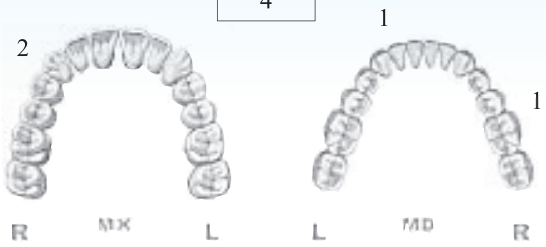
Cast-Radiograph Evaluation

Case # **Patient**

Total Score: 22

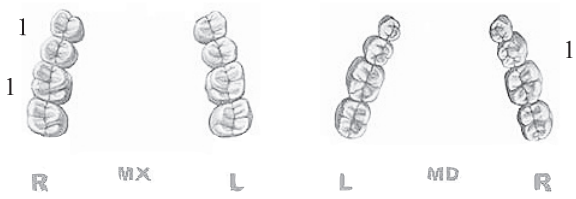
Alignment/Rotations

4



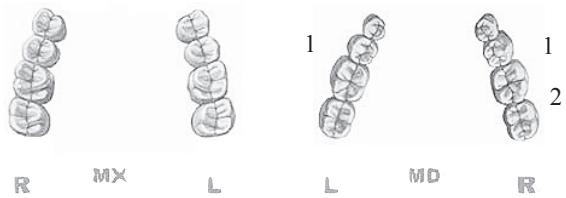
Marginal Ridges

3



Buccolingual Inclination

4

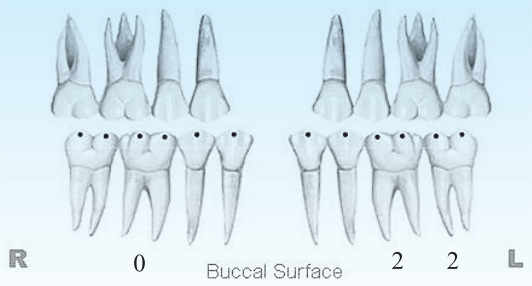


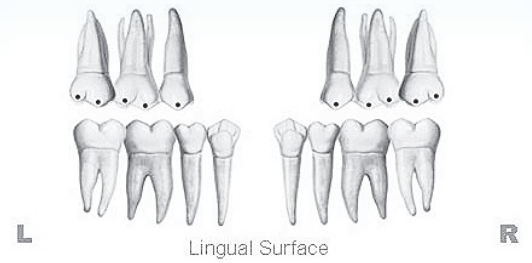
Overjet

0

Occlusal Contacts

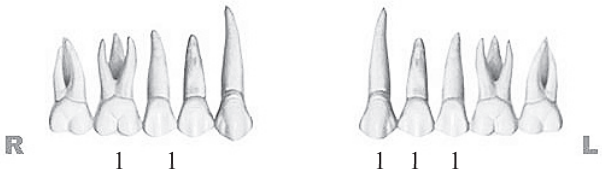
0 4 0





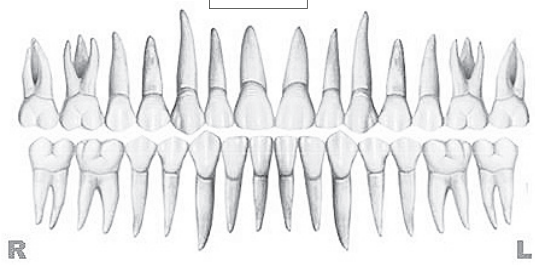
Occlusal Relationships

5



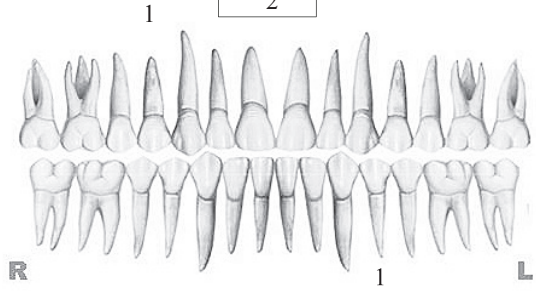
Interproximal Contacts

0



Root Angulation

2



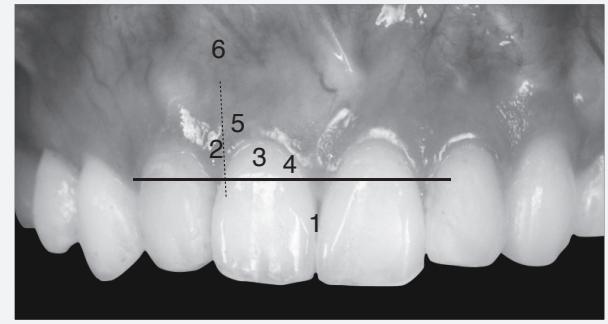
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

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

Total Score: = 8

1. Pink Esthetic Score

Total = 2

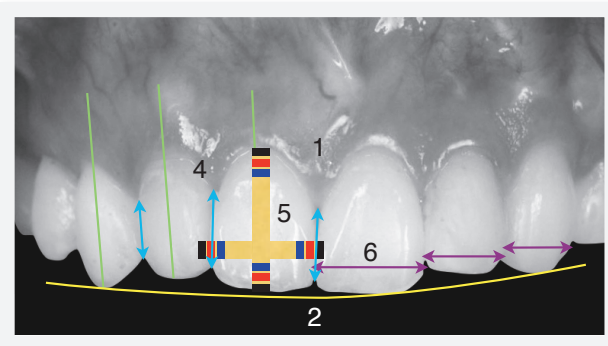


1. Mesial Papilla	0	1	2
2. Distal Papilla	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2

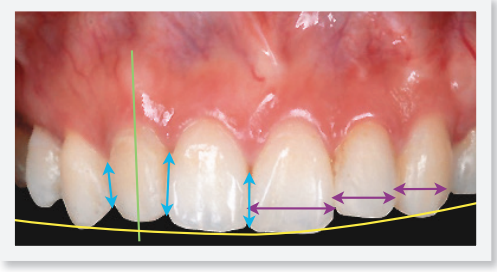
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	(0)	1	2
4. Level of Gingival Margin	0	1	(2)
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 6



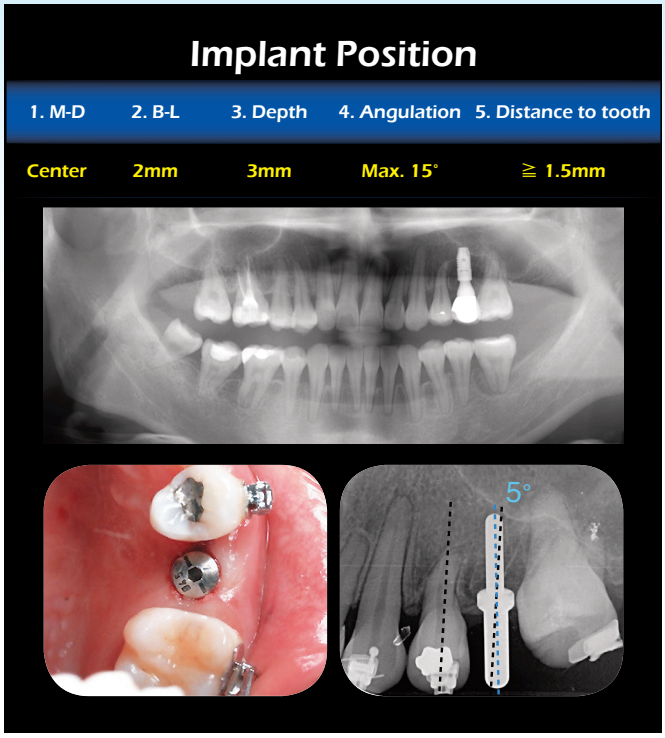
1. Midline	0	1	2
2. Incisor Curve	0	1	2
3. Axial Inclination (5°, 8°, 10°)	0	1	2
4. Contact Area (50%, 40%, 30%)	0	1	2
5. Tooth Proportion (1:0.8)	0	1	2
6. Tooth to Tooth Proportion	0	1	2



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

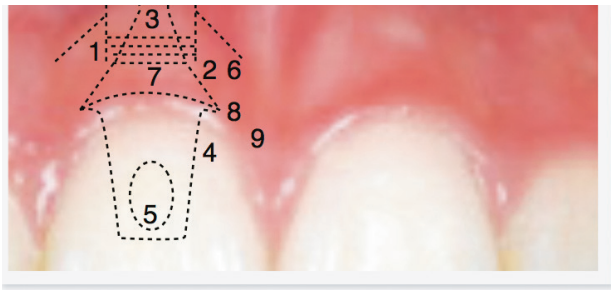
3. Implant Position



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



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	absent
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