Asymmetric Oligodontia and Acquired Class III Malocclusion: Space Management and Site Development for an Implant-Supported Prosthesis

Abstract

History: *A 26-year-old male presented with a severe, asymmetric Class III, partially edentulous malocclusion that was associated with decreased facial height due to a midface deficiency. The chief complaints were poor masticatory function and compromised dentofacial esthetics.*

Diagnosis & Etiology: *A decreased vertical dimension of occlusion (VDO) was associated a deep overbite (8mm), deviated maxillary dental midline (3.5mm to the right), skeletal Class III (ANB -5˚), asymmetric absence of six permanent teeth (UR4, UR5, UL5, LR4, LR5, and LL5), and two retained deciduous teeth. The probable etiology for the anterior crossbite was ectopic eruption to the palatal of the upper central incisor(s). Severe deepbite reflected the absence of multiple posterior teeth, and the upper midline deviation was due to the loss of both upper premolars on the right side. The patient was a good candidate for camouflage treatment because in centric relation (C_R) the facial profile was acceptable, molars were near Class I, and the incisors occluded in an end-to-end relationship.*

Treatment: *The upper deciduous lateral incisor was extracted and the space was closed. A full fixed appliance was bonded on all permanent teeth as well as the lower right deciduous second molar. Space was created in the UR4 area for an implant-supported prosthesis (ISP). The anterior crossbite was corrected by bonding bite turbos on the posterior teeth, placing an open coil spring in the UR4 area, and utilizing Class III intermaxillary elastics. In the 29th month of treatment, the UR4 implant was placed, and all fixed appliance were removed when the ISP was delivered. Retention was a lower fixed 3-3, and clear overlay retainers in both arches.*

Outcome: *Following 33 months of interdisciplinary treatment, this difficult malocclusion, with a Discrepancy Index of 66 points, was treated to a Cast-Radiograph Evaluation score of 15 points and a Pink and White esthetic score of 4 points. The patient was very pleased with the treatment outcome. (J Digital Orthod 2018;52:24-46)*

Key words:
Multiple missing teeth, oligodontia, skeletal Class III pattern, Class III molar relationship, dentofacial asymmetry, asymmetric mechanics, interdisciplinary treatment, open coil spring, bite turbos, Class III intermaxillary elastics, implant site development, 2B-3D rule

Introduction

The dental nomenclature for the current case report is a modified Palmer notation for both the deciduous and permanent teeth. The four oral quadrants are upper right (*UR*), upper left (*UL*), lower right (*LR*) and lower left (*LL*). Relative to the midline in each quadrant, deciduous teeth are designated from a to e, and corresponding permanent teeth are numbered from 1 to 8. For example, an upper right first premolar is UR4, and lower right second deciduous molar is LRe.

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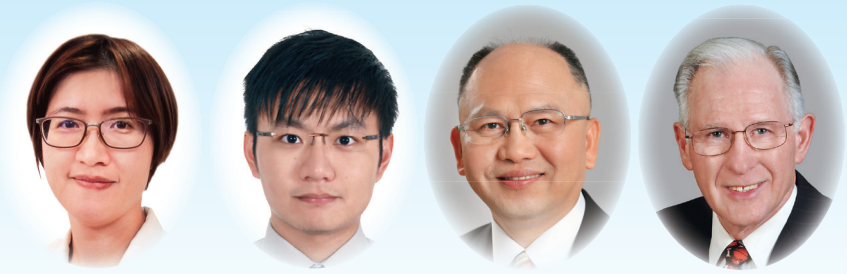


Hypodontia denotes the lack of development of one or more teeth. Oligodontia designates a hypodontia with six or more congenitally missing teeth, excluding the third molars.[1,2] The relative frequency of the missing teeth varies between ethnic groups, but teeth commonly absent are the mandibular second premolar, the maxillary lateral incisor, the maxillary second premolar, the mandibular lateral incisor, and the mandibular central incisor.[3]

Fig. 1: Pre-treatment facial and intraoral photographs

Patients with hypodontia often present with a number of associated traits such as decreased mandibular plane angle (*MPA*), lower facial height (*LFH*), vertical dimension of occlusion (*VDO*), and lip protrusion. Increased overbite is a common dental manifestation often associated with decreased axial inclination of the lower incisors, increased interincisal angle, extrusion of the lower incisors, and a deep curve of Spee.[4]

Increased numbers of missing teeth is directly related to edentulous spaces, permanent tooth displacement, severe deepbite, and the need for complex interdisciplinary treatment. Space closure options are increasingly unrealistic when there are multiple missing teeth. Orthodontic treatment typically focuses on space distribution and preprosthetic alignment to facilitate a restoration of the occlusion.[4] The current patient (*Figs. 1-7*) presented with decreased midfacial height oligodontia, dentofacial asymmetries and an acquired (*collapsed*) Class III malocclusion (*decreased MPA but increased LFH*). This usual combination of traits reflects a severe decrease in midfacial height. Orthodontic treatment with a full fixed appliance, implant site development, and implant-supported prosthesis (*ISP*) focuses on esthetic and functional rehabilitation of the occlusion.[5]

Diagnosis and Etiology

A 26-year-old male pursued orthodontic evaluation with a chief complaint of compromised dentofacial esthetics. The intermaxillary relationship was examined with the teeth in maximum intercuspation, centric occlusion (C_O), and with the mandibular condyles seated in the fossa, i.e. centric relation (C_R). In C_O the clinical examination revealed a prognathic profile, protrusive lower lip, and an anterior crossbite (*Figs. 1 and 2*). In C_R the incisors were end-on, molars were near Class I, and the facial profile was acceptable. Temporomandibular joint (*TMJ*) morphology was normal in the open and closed positions, but the condyle was anterior and inferior to the fossa consistent with a functional shift into anterior crossbite (*Fig. 3*). There were no signs nor symptoms of TMJ dysfunction. In C_O facial form

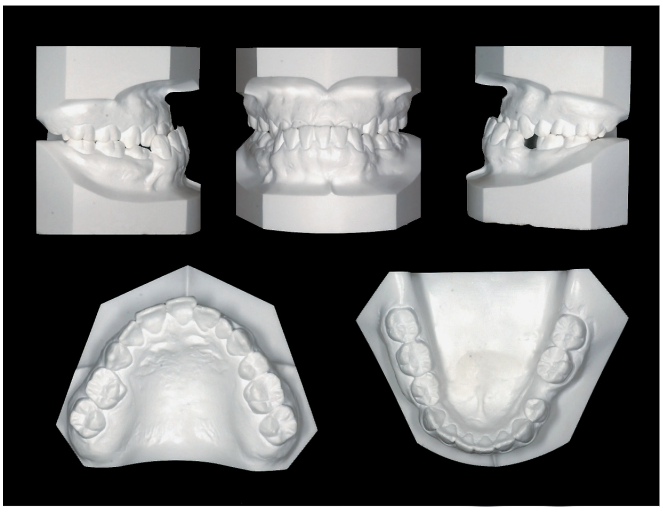


Fig. 2: Pre-treatment study models (casts)

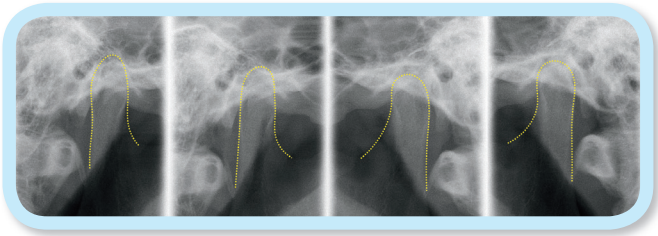


Fig. 3:
Transcranial radiographs of the temporomandibular joints (TMJs) prior to treatment are shown from the left: Right TMJ closed, Right TMJ open, Left TMJ open, and Left TMJ closed.

was relatively symmetric in the frontal plane (*Fig. 1*), but the profile was markedly concave (*G-SN-Pg' -6˚*). Upper lip prominence was severely deficient, -5.5mm to the E-Line (*Fig. 4 and Table 1*).

Plaster casts (*Fig. 2*) revealed a Class I molar relationship on the right side and an end-on Class III molar relationship on the left. The canine relationships were Class III bilaterally (*Fig. 2*), and there was an anterior crossbite from canine to canine. The maxillary arch form was rotated counterclockwise (*Fig. 5*) consistent with the congenital absence of both upper right premolars (*Fig. 6*). Despite an edentulous space in the area of LL5, the lower arch remained symmetric (*Fig. 1*). The lower dental midline was coincident with the facial midline, but the upper dental midline was shifted 3.5mm to the right (*Fig. 1*).

Fig. 4:
Pre-treatment cephalometric radiograph in centric occlusion (C_O). Note the relative midface deficiency is due to decreased midface height and overclosure of the mandible (flat MPA).

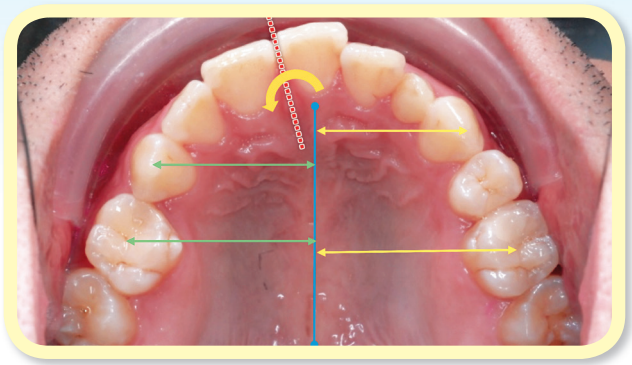


Fig. 5:
Canine and molar positions were asymmetric due to the pattern of the congenitally missing teeth. The right side of the patient's maxilla is underdeveloped as shown by the colored arrows relative to the midline (blue line). Using the mid-palatal raphae (red dotted line) as a reference, the anterior maxillary arch is rotated counterclockwise (yellow curved arrow).

CEPHALOMETRIC SUMMARY			
SKELETAL ANALYSIS			
	PRE-Tx	POST-Tx	DIFF.
SNA˚ (82°)	82˚	83˚	1˚
SNB˚ (80°)	87˚	85˚	2˚
ANB˚ (2°)	-5˚	-2˚	3˚
SN-MP˚ (32°)	26˚	27˚	1˚
FMA˚ (27°)	19˚	20˚	1˚
DENTAL ANALYSIS			
U1 To NA mm (4 mm)	6.5 mm	10 mm	3.5 mm
U1 To SN˚ (104°)	107˚	117˚	10˚
L1 To NB mm (4 mm)	4.5 mm	3 mm	1.5 mm
L1 To MP˚ (90°)	80˚	87˚	7˚
FACIAL ANALYSIS			
E-LINE UL (2-3 mm)	-5.5 mm	-4 mm	1.5 mm
E-LINE LL (1-2 mm)	-1 mm	-2.5 mm	1.5 mm
%FH: Na-ANS-Gn (56%)	58%	59%	1%
Convexity: G-Sn-Pg' (13°)	-6˚	-2˚	4˚

Table 1: Cephalometric summary

The panoramic radiograph (*Fig. 6*) documents significant dental problems contributing to the malocclusion: 1. six congenitally missing permanent teeth (*UR4, UL5, UL5, LR4, LR5, LL5*), 2. two retained deciduous teeth (*ULb, LRe*), and 3. a 7mm atrophic edentulous ridge in the area of the LL5. The cephalometric evaluation (*Table 1*) revealed decreased facial convexity (*-6°*), increased LFH (*58%*) relative to total facial height (*Na-Gn*), and a prognathic mandible (*SNA 87°, SNB 82°, ANB -5°*).

Fig. 6: Pre-treatment panoramic radiograph

The mandibular plane angle was flat (*SN-MP 26°, FMA 19°*), and the lower incisors had a decreased axial inclination (*80°*). With the mandible positioned in centric relation (C_R), the incisors were in an end-to-end occlusion and the facial profile was acceptable, which indicates that conservative camouflage treatment was a viable option (*Fig. 1*). The American Board of Orthodontics (*ABO*) Discrepancy Index (*DI*) was 66 as shown in the subsequent worksheet. The most significant problems were the anterior crossbite (*38 points*) and congenital missing teeth (*12 points*).

Treatment Objectives

The principal objectives for the treatment plan were to improve the prognathic facial profile, achieve a Class I molar relationship, correct the anterior crossbite, and optimize the intermaxillary relationship with space management. Additional

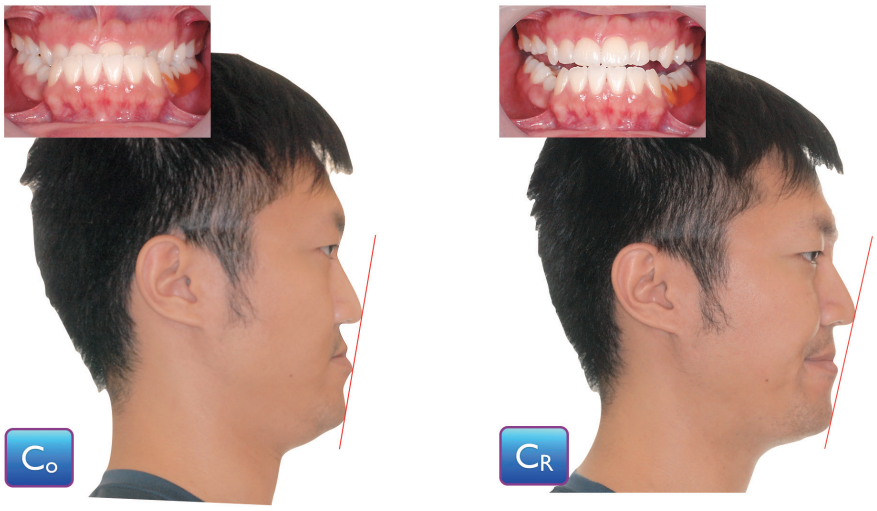


Fig. 7:
With the mandible positioned in centric relation (C_R), the incisors were in an end-to-end occlusion and the facial profile was acceptable.

esthetic goals were correction of the dental midline discrepancy and improvement of maxillary anterior alignment.

Treatment Alternatives

To resolve the midline and interdigitation discrepancies, asymmetric space closure was required in both arches. Because of the large sagittal discrepancy (*ANB -5˚*), orthognathic surgery to set back the mandible was the initial treatment option. The second treatment plan was a conservative, camouflage approach involving proclination of the upper anterior segment and retraction of the lower arch. After considering the pros and cons of each option, the patient preferred the second treatment option including an ISP to restore the UR4. He realized that the retained deciduous molar (*LRe*) will eventually require replacement with ISP, but he could only afford one ISP at present.

Treatment Progress

A 0.022-in Damon Q® (*Ormco, Glendora, CA*) passive self-ligating (*PSL*) fixed appliance was selected. The archwire sequence and applied mechanics is documented in the wire sequence chart (*Table 2*). For the lower arch, low torque brackets were bonded upside down to achieve increased torque on the lower incisors, and high torque brackets were placed on the lower canines. The mesiodistal width of the restored LRe was reduced to 7.5mm to serve as a future implant site.[6] The initial archwire was 0.014-in copper-nickel-titanium.

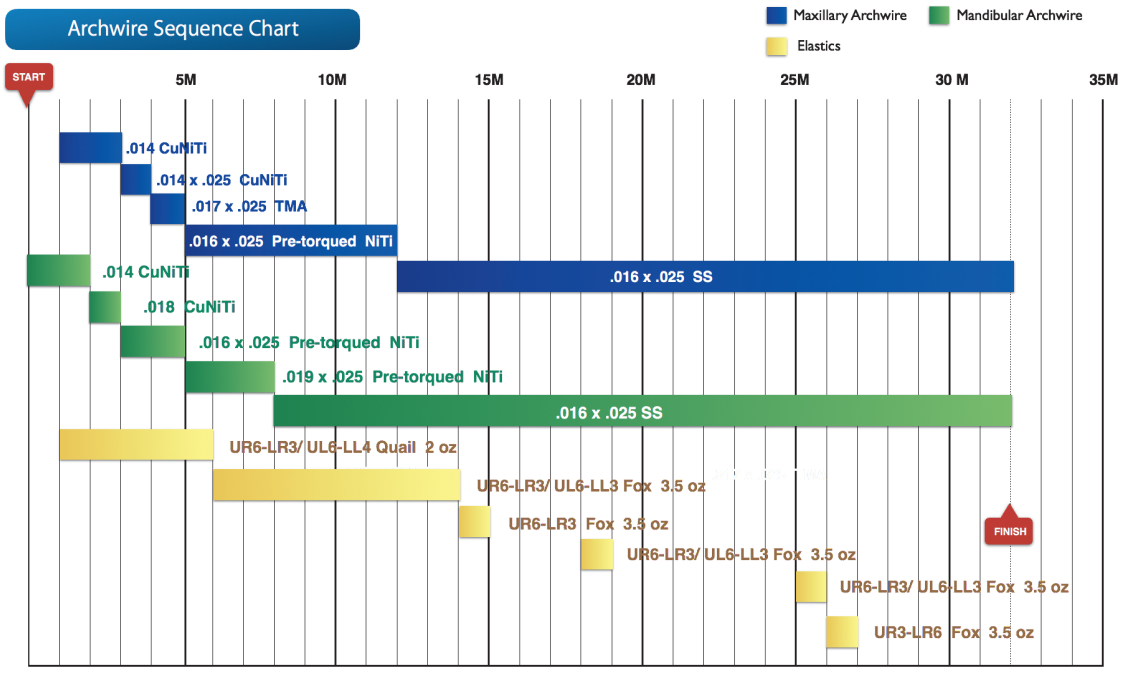


Table 2: Archwire Sequence Chart

One month later, the maxillary central incisors were bonded with standard torque brackets and the canines were bonded with high torque brackets. The initial archwire was 0.014-in copper-nickel-titanium. Posterior bite turbos, made with Fuji II® type II glass Ionomer cement (*GC America, Alsip IL*), were installed bilaterally on the maxillary second molar occlusal surfaces to create intermaxillary space. An open coil spring (*Ormco, Glendora, CA*) activated 2mm was used to create an implant site in the UR4 area, and power chains were used to close the edentulous LL5 space. An additional open coil spring was used to open the UR4 implant site, increase the axial inclination of the upper anterior segment, and retract the UR posterior segment. Early light short Class III elastics (*Quail, 3/16-in, 2-oz; Ormco*) were used to correct the sagittal discrepancy. Collectively, these mechanics corrected the anterior crossbite (*Fig. 8*).

In the 3rd and 4th month, the maxillary archwire sequence was 0.014x0.025-in CuNiTi and 0.017x0.025-in TMA. To increase the axial inclination of the upper incisors, a 0.016x0.025-in pre-torqued NiTi was inserted for 7 months. After 16 months of active treatment, the anterior crossbite was corrected, and the UL space was closed. Bite turbos were progressively removed beginning at the 21st month of treatment to allow posterior contact, as

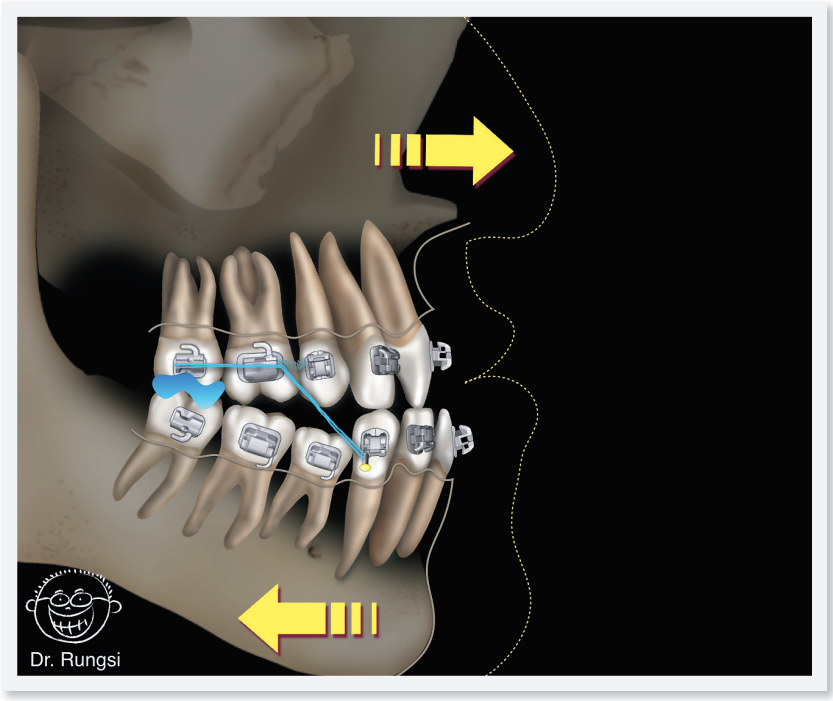


Fig. 8:
The collapsed Class III malocclusion associated with asymmetric missing teeth was corrected with three mechanical interventions: open coil spring to prepare an UR4 implant site, Class III elastics, and bite turbos. Collectively these mechanics tended to protract the maxillary arch and retract the mandibular arch, as shown with the yellow arrows.

the curve of Spee in the lower arch was corrected.

From 2-8 months, the sequence for the lower archwire was 0.018-in CuNiTi, 0.016x0.025-in pre-torqued NiTi, and 0.019x0.025-in pre-torqued NiTi. In the 8th month, the archwire was changed to 0.016x0.025-in SS with 15° of lingual root torque because the upside-down low torque brackets and pre-torqued NiTi wire were insufficient to control the axial inclinations (*Table 2*).

At 27 months, the upper dental midline was coincident with the incisive papilla. The space for implant site was 7.5mm,[5] and the occlusion was optimally interdigitated as the lower space was closed (*Figs. 9-11*).

Implant Placement

A cone-beam computed tomography (*CBCT*) scan was used to evaluate the bone volume and distribution in the implant site (*Fig. 12*). A slice from the center of the implant site was selected and the alveolar bone mass was measured: height 12.6mm, width 9mm. The fixture selected was a Nobel Replace Conical Connection NP Ø3.5xH10mm with a Healing Abutment Conical Connection NP Ø3.6xH5mm (*Nobel BiocareTM, Switzerland*).

Under local anesthesia, a #15c scalpel blade was used for a crestal incision on the palatal side of the ridge. A sulcular incision was performed on the buccal surface with a #12 blade from the distal line angle of UR3 to the mesial line angle of the UR6, and a full

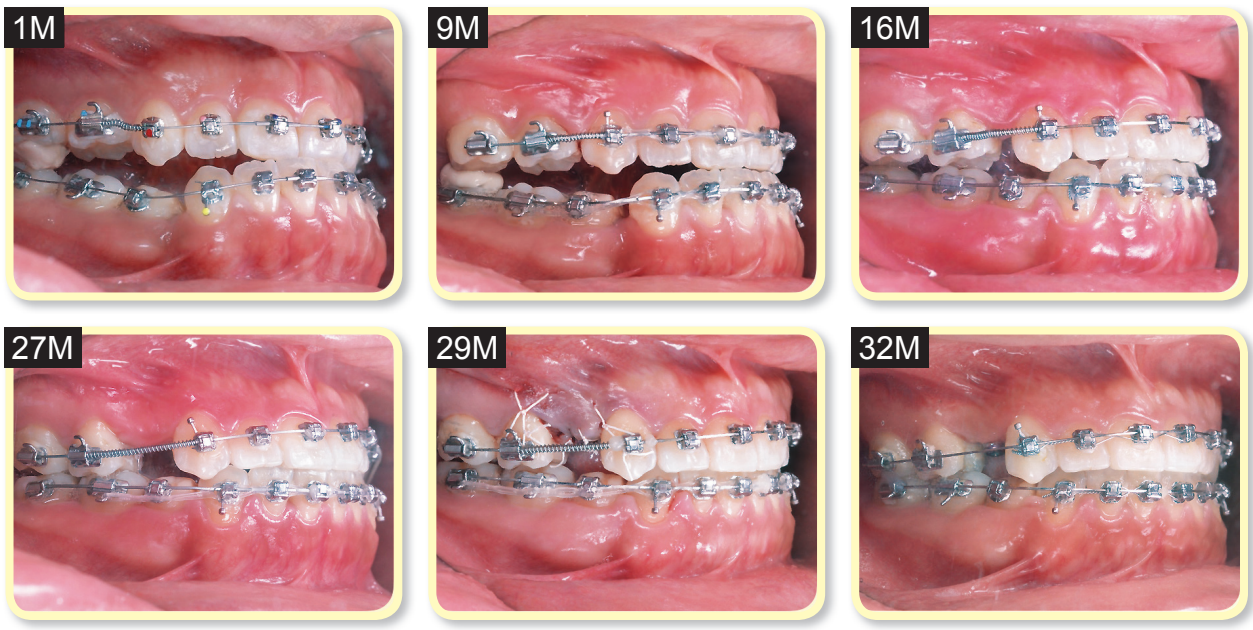


Fig. 9:
Correction of the anterior crossbite is shown in monthly intervals: first (1M), ninth (9M), sixteenth (16M), twenty-seventh (27M), twenty-ninth (29M), and thirty-second (32M).

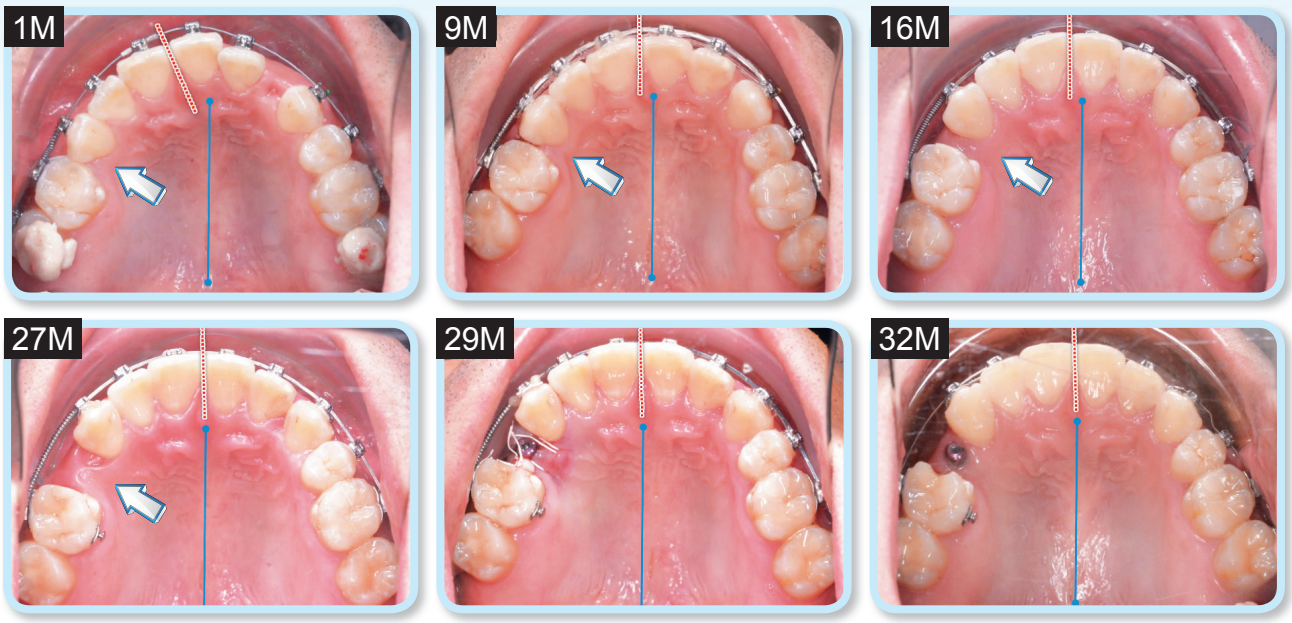


Fig. 10:
Maxillary midline correction and UR4 implant site development is shown in monthly intervals: first (1M), ninth (9M), sixteenth (16M), twenty-seventh (27M), twenty-ninth (29M), and thirty-second (32M). The palatal midline (blue line) and raphae (red dotted line) are shown in relation to the implant site (white arrow).

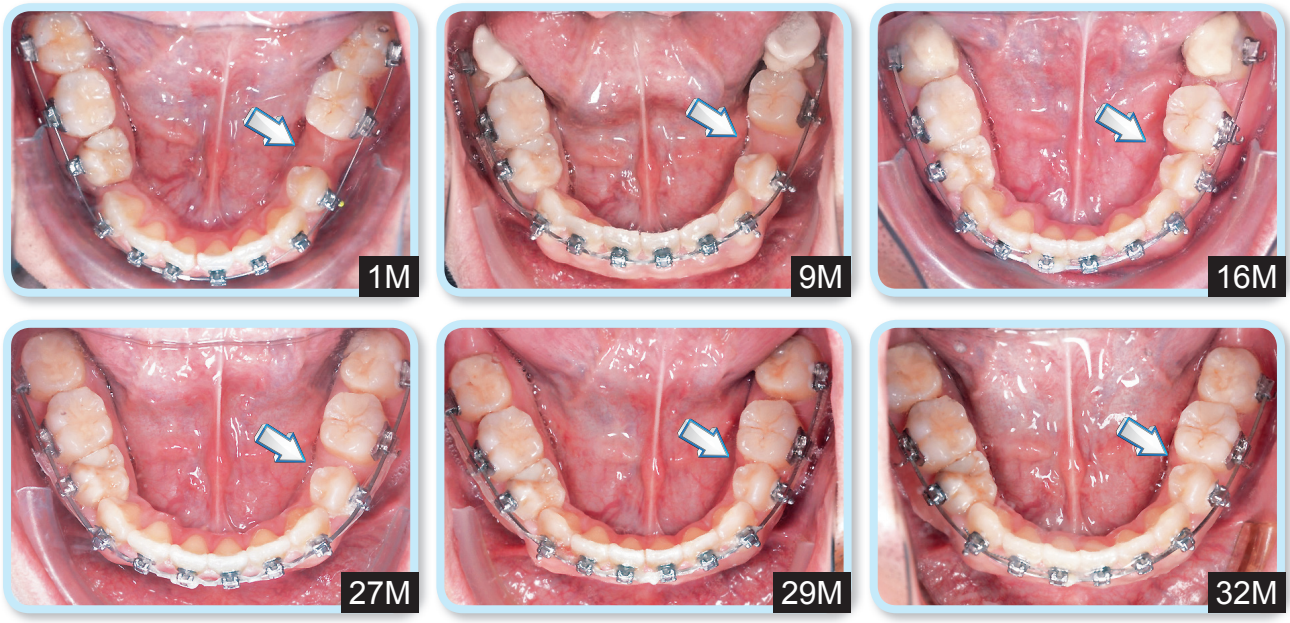


Fig. 11: The white arrow points to progress as the LL5 space is closed from one (1M) to thirty-two months (32M).

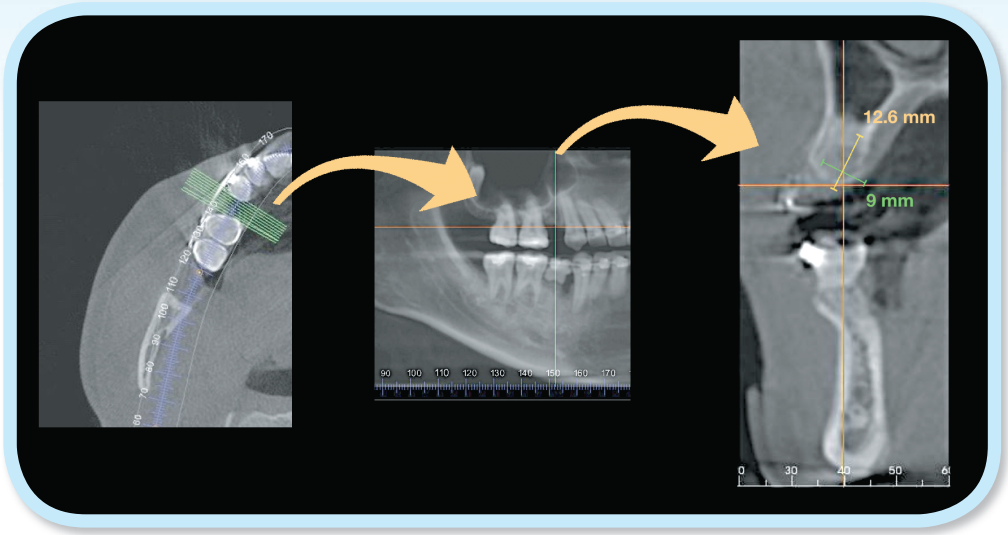


Fig. 12:
A CBCT scan shows the dimensions of the implant site in the axial (left), sagittal (middle) and frontal views (right). The alveolar bone volume was assessed as height 12.6mm, and width 9mm in the frontal image (right).

thickness soft tissue flap was reflected. Exposure of the bone revealed an adequate ridge to place a 3.5mm diameter implant. The initial lancer drill produced an osteotomy that was fitted with a guide pin to evaluate the insertion path with a periapical radiograph. The osteotomy was excessively oriented to the mesial, so it was adjusted prior to placing the implant. Following the specifications of the implant manufacturer, the fixture was installed in the center of the ridge according to the 2B-3D rule, which is defined as 2mm of buccal bone thickness, and fixture depth 3mm apical to the expected crown margin (*Figs. 13 and 14*).[7] As shown in Fig. 13h, the fixture was connected with a healing abutment (*Ø3.6xH5.0mm*), and the flap was sutured with interrupted 4-0 GORE-TEX® (*Flagstaff, AZ*). After 1 week, the sutures were removed.

Implant Prosthesis Fabrication

Four months after surgical placement, the implants were uncovered, and excessive gingival tissue was removed using a dioxide laser (*Epic X, Epic, Verona, WI*). The healing abutment was replaced by a Snappy Abutment 5.5 Nobel Replace NP 1.5mm (*Nobel Biocare™, Switzerland*). A snap-on impression coping was used for abutment level impression with a closed tray. After the impression, a healing cap was fitted to prevent soft tissue overgrowth of the abutment. Two weeks later, the crown was delivered and the marginal fit was checked with an explorer and periapical radiographs. The progressive prosthetic procedures are shown in a panel of 12 photographs (*Fig. 15*).

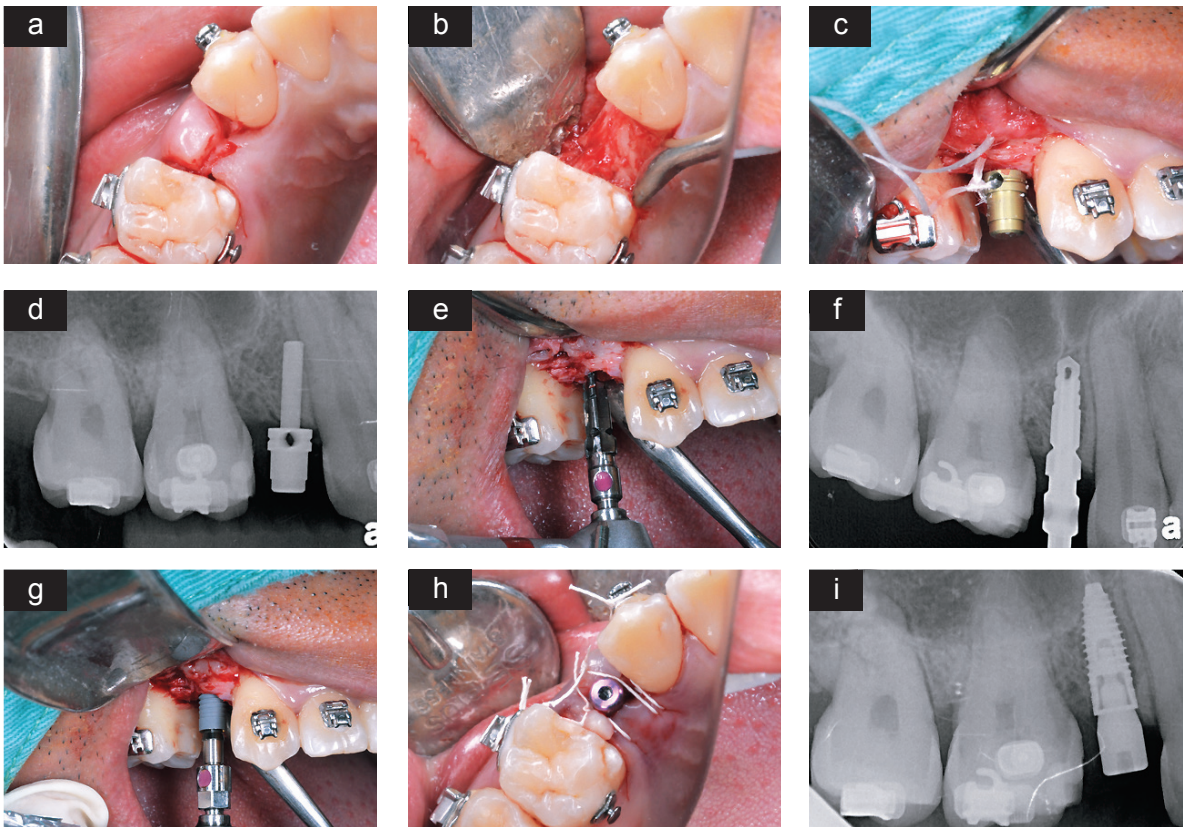
Following 33 months of interdisciplinary treatment,

maxillary and mandibular clear overlay retainers were delivered to wear full-time for the first six months and nights only thereafter. A fixed retainer was bonded from lower right canine to lower left canine.

Treatment Results

The facial profile was improved and facial esthetics were more harmonious. A near ideal dental alignment was achieved: normal overbite and overjet, and bilateral Class I buccal segments. The anterior crossbite was corrected, resulting in a pleasant smile arc with a more youthful facial appearance (*Figs. 16 and 17*).

The post-treatment panoramic radiograph demonstrated adequate root alignment. Additional resorption of the LRe root was noted, but the tooth remained stable (*Fig. 18*). Superimposed cephalometric tracings revealed increased axial inclination of the maxillary incisors, slight retraction of the maxillary molars, retraction of the lower lip and a less prognathic profile (*Figs. 19 and 20*). The



■ *Fig. 13:*
The implant surgical procedure is illustrated: (a) mid-crestal and sulcular incisions were performed for flap reflection, (b) occlusal view of the exposed osseous ridge, (c) guide pin was placed in the osteotomy, (d) a periapical film was exposed with the guide pin to check the insertion path and orientation of the osteotomy, (e) osteotomy is completed, (f) periapical film was exposed with the final drill in place to check the insertion path, (g) 3.5x10mm implant fixture is inserted, (h) healing abutment (3.6x5.0mm) is installed, and the flap is sutured with direct loop interrupted 4-0 GORE-TEX®, and (i) periodical radiograph of the final result.

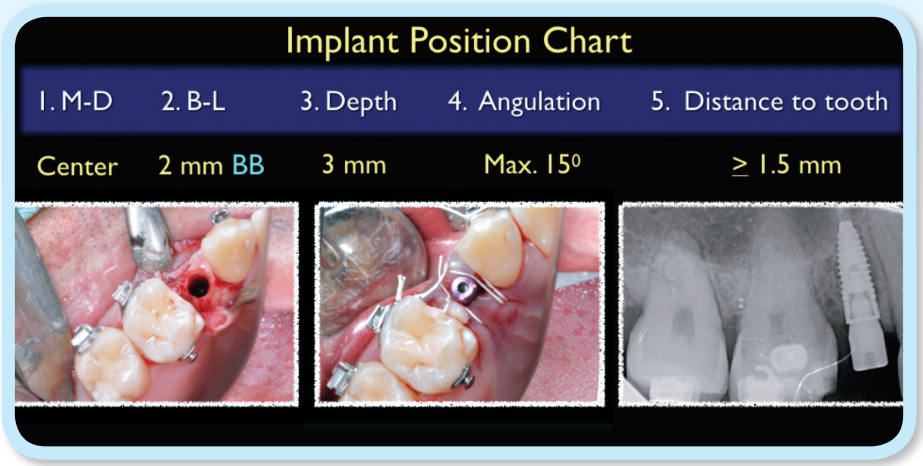


Fig. 14:
The implant position chart, composed of two intraoral photographs and a periapical radiograph, documents the five parameters for placement of the UR4 fixture. Left Image: 1. M-D center of the site in the mesial-distal (M-D) position, and 2. buccal-lingual (B-L) position with 2mm buccal bone thickness. Center Image: 3. implant fixture is positioned 3mm below the future crown margin. Right Image: 4. angulation (less than 15°), and 5. distance from adjacent teeth is at least 1.5mm.

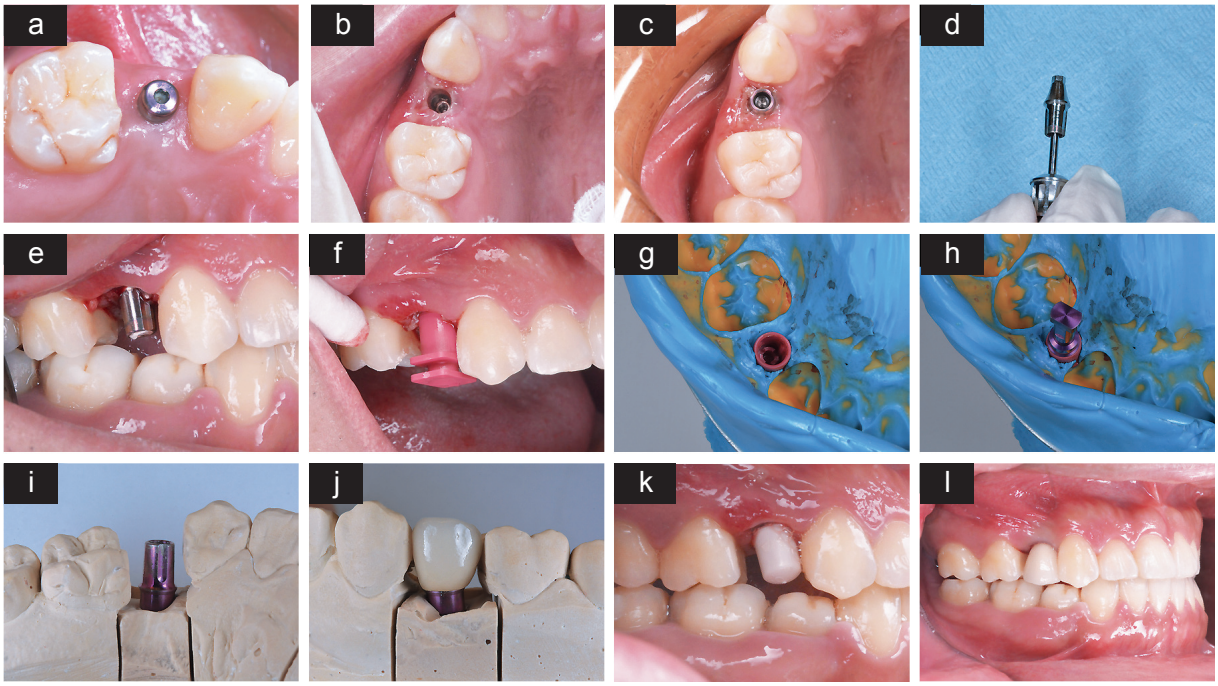


Fig. 15:
The prosthetic procedure is: (a) healing cap in place, (b) removal of healing abutment, (c) excessive gingiva above the fixture is removed with a dioxide laser (Epic X, Epic, Verona, WI), (d) Snappy Abutment 5.5 Nobel Replace NP 1.5mm is chosen, (e) abutment is fitted and placed (f) Snappy Abutment 5.5 Impression Coping NP is inserted into the soft tissue sulcus, (g) pick-up impression with polyvinyl siloxane shows the pink outline of the impression coping, (h) Snappy Abutment 5.5 Abutment Replica NP is "snapped" into the coping that was embedded in the impression, (i) impression is poured in type IV dental stone to prepare a working cast, (j) final prosthesis is fabricated and fitted on the working cast, (k) healing cap supports the soft tissue during healing, and (l) permanent crown is viewed from the buccal aspect.

Fig. 16: Post-treatment facial and intraoral photographs

Fig. 17: Post-treatment study models (casts)

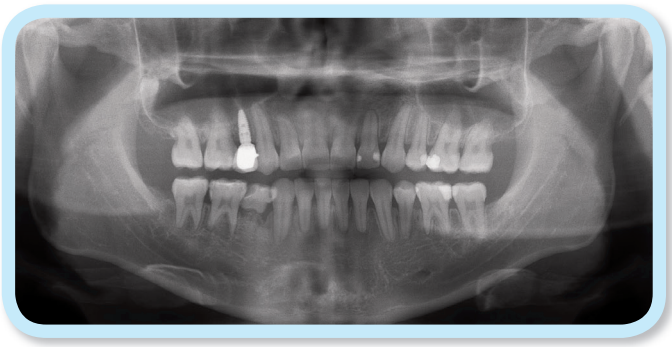


Fig. 18: Post-treatment panoramic radiograph

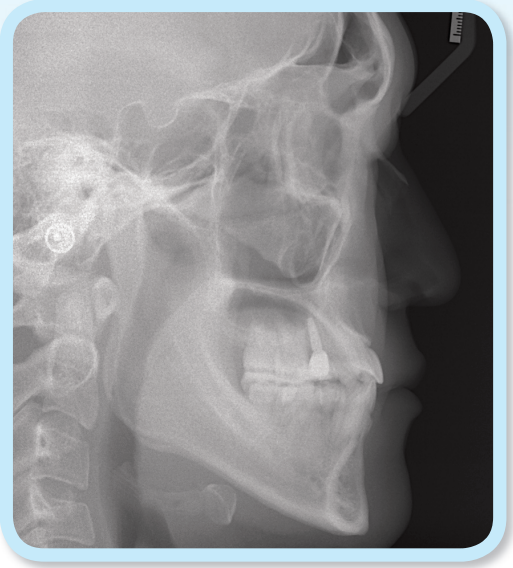


Fig. 19: Post-treatment cephalometric radiograph

ABO Cast-Radiograph Evaluation (*CRE*) score was 13 points (*Worksheet 2*). The major CRE discrepancies were alignment (*3 points*), bucco-lingual inclination (*6 points*), and occlusal relationships (*3 points*).

Discussion

Asymmetric oligodontia, ectopic eruption and a prognathic skeletal pattern (*ANB -5˚*) resulted in severe dentofacial malocclusion requiring carefully coordinated interdisciplinary treatment. The patient preferred conservative treatment, so a careful differential diagnosis was essential to determine whether a non-invasive approach was indicated or even feasible. Space management with orthodontics required careful application of asymmetric intermaxillary mechanics. Three important aspects of case management are discussed in detail as follows:

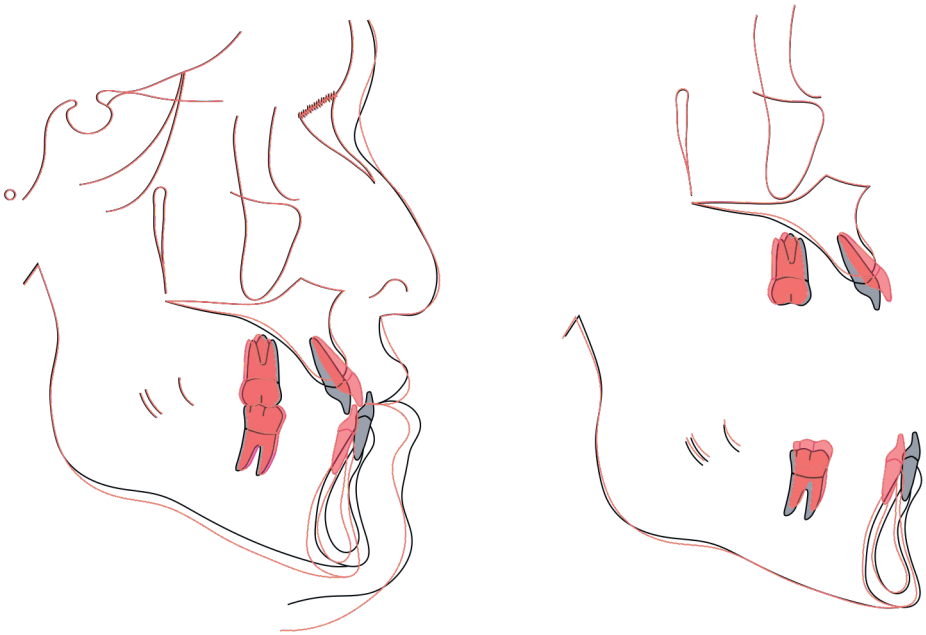
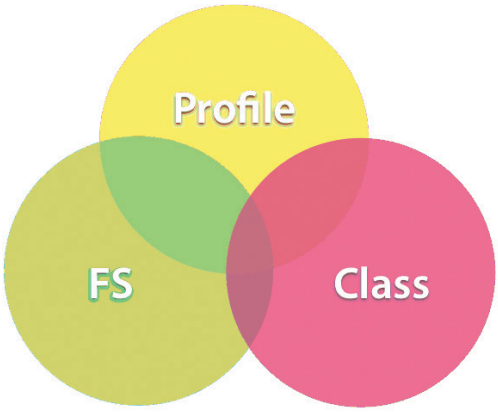


Fig. 20:
Superimposed tracings of the initial (black) and finish (red) cephalometric films reveal the skeletal and dental changes that occurred during treatment.

Correction of a Collapsed Class III malocclusion with Anterior Crossbite

1. Examination

The 3-Ring Diagnosis, developed by Dr. John Lin,[8] is an effective method for diagnosing Class III malocclusions that are amenable to conservative therapy. There are three favorable indicators: an orthognathic profile (*acceptable facial balance*) in centric relation, buccal segments that are approximately Class I, and a functional shift into maximal intercuspation. Other favorable factors are a less than average mandibular plane angle and no open bite (*Fig. 21*).[9]



Profile: Orthognathic profile at C_R *position*
Class: Canine and molar classification
FS: Functional shift ($C_O \neq C_R$)

Fig. 21:
The Class III diagnostic system of Dr. John Lin evaluates the facial profile and molar classification in C_R, as well as the functional shift from C_R to C_O. If the profile is acceptable in C_R, the molars are in or near Class I, and there is a significant functional shift, the patient can usually be effectively managed with conservative camouflage treatment.

2. Diagnosis

The functional shift was an important consideration. In centric relation (C_R), there was an end-on occlusion of the incisors, the facial profile was acceptable, and the ANB angle decreased three degrees. These positive factors revealed that conservative camouflage treatment of the acquired Class III malocclusion was a viable option.[10]

3. Treatment

Camouflage treatment often results in increased axial inclination of the maxillary incisors and decreased axial inclination of the mandibular incisors, particularly if there is an underlying Class III skeletal discrepancy (*Fig. 22*).[8] Orthodontic mechanics for predictable anterior crossbite correction includes proper bracket torque selection, bite turbos, light-force Class III elastics, and open coil springs.[10]

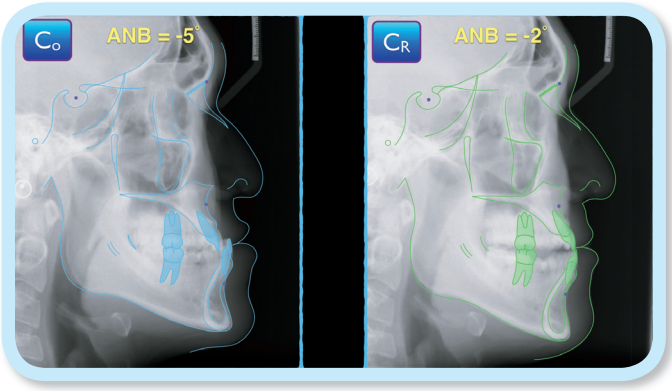


Fig. 22:
Tracings superimposed on cephalometric films, exposed in centric occlusion (C_O) and centric relation (C_R), are shown as left and right images, respectively. The C_O tracing in blue reveals an -5° ANB angle when the patient is in maximum intercuspation (C_O). The C_R tracing in green documents that ANB has increased to -2° and the incisors have an end-on occlusion.

Bite turbos were bonded on the posterior teeth to create intermaxillary space. Early light short elastics were utilized to increase the axial inclination of the maxillary anterior teeth and retract the mandibular anterior teeth. In addition to making space for the implant site development, the open coil spring tipped the maxillary incisors anteriorly and retracted the maxillary posterior teeth. If a rectangular archwire and pre-torqued brackets fail to correct the axial inclination, a pre-torqued archwires such as a 0.016x0.025-in NiTi or a 0.019x0.025-in NiTi (*Ormco, Glendora, CA*) are recommended.[8,11]

The pre-treatment angle of L1-MP was 80˚, and the side effect of Class III elastics was to decrease the axial inclination of the mandibular incisors. Upside down low torque brackets bonded on the lower anterior teeth were insufficient for controlling axial inclinations. Therefore, a 9 month sequence of progressive pre-torqued archwires was used: 0.016x0.025-in NiTi archwire, a 0.019x0.025-in NiTi, and a 0.016x0.025-in stainless wire. The latter archwire had 15˚ of lingual root torque to complete the desired root retraction of the mandibular incisors.

4. Evaluation

For the conservative correction of Class III skeletal malocclusions it is wise to limit maxillary incisor inclination to ≤120˚ to the sella-nasion (*SN*) line, and mandibular incisor inclination to ≥80˚ relative to the mandibular plane (*MP*). The post-treatment U1-SN angle was 117˚ and L1-MP was 87˚, so the treatment results were within established guidelines.[12]

Dentofacial Asymmetries

1. Examination

Dentofacial asymmetries can be categorized as dental, skeletal or functional. A thorough clinical dental midline examination with a radiographic survey is necessary to determine the extent of the skeletal, dental, and functional involvement (*Fig. 23*).[13-15] A comprehensive evaluation includes assessment of the dental midlines in the following positions: mouth open, C_R (*centric relation*), initial contact, and C_O (*centric occlusion*). True dentoskeletal asymmetries, if uncomplicated by other factors, will exhibit similar midline discrepancies in C_R and C_O. On the other hand, asymmetries due to occlusal interference may result in a mandibular functional shift following initial tooth contact.

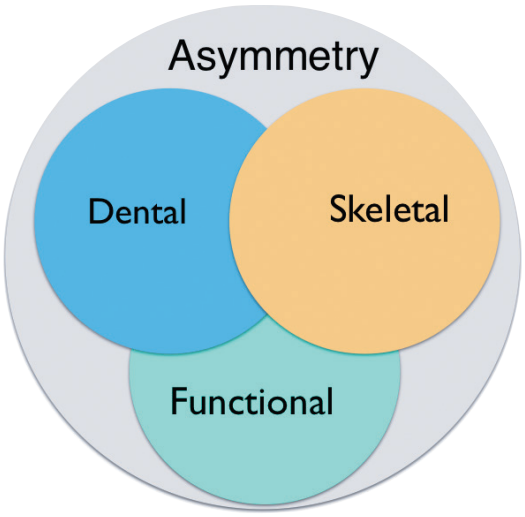


Fig. 23:
Dentofacial asymmetries may be dental, skeletal and/or functional.

In addition to the clinical evaluation, the differentiation between various types of asymmetry in the frontal plane is best assessed with radiographs. The most precise examination is the postero-anterior (*P-A*) projection and the second most useful examination is a panoramic view. When referring to the P-A projection, the zygomatico-frontal suture is an effective horizontal reference line and crista galli delineates the vertical reference line. Panoramic radiography is useful for detecting gross pathology, missing dentition, supernumerary teeth, and abnormal form of the mandibular ramus and condyle bilaterally.[10]

2. Diagnosis

Functional shifts are assessed according to the dental midline relationship from the open mouth to C_O position (*Fig. 24*). The open mouth relationship with the jaws relaxed assesses the dentoskeletal asymmetry if any. At initial contact, inclined planes of interfering cusps move the mandible in a lateral and/or P-A direction. The full functional manifestation of the shift is in maximal intercuspation (C_O). The panoramic radiograph revealed that the shape of the mandibular rami and condyles were symmetrical (*Fig. 6*), so skeletal asymmetry was ruled out. Six congenitally missing teeth were distributed asymmetrically in both arches (*Fig. 6*). A maxillary occlusal photograph shows the asymmetric position of multiple teeth bilaterally (*Fig. 5*). Therefore, it was concluded that the dentofacial asymmetry of this patient was predominately of dental origin.[10]

3. Treatment

To achieve an optimal result (*Fig. 25*), differential management for each type of dentofacial asymmetry is indicated. The present patient has a complex problem involving skeletal, dental and functional elements as follows: anterior crossbite, skeletal Class III (*prognathic mandible*), bilateral canine Class III relationships, and a left molar Class III

Fig. 24:
A shift in the dental midline from mild to severe is observed from left to right as the mouth is closed: mouth opening —> initial tooth contact —> C_O.

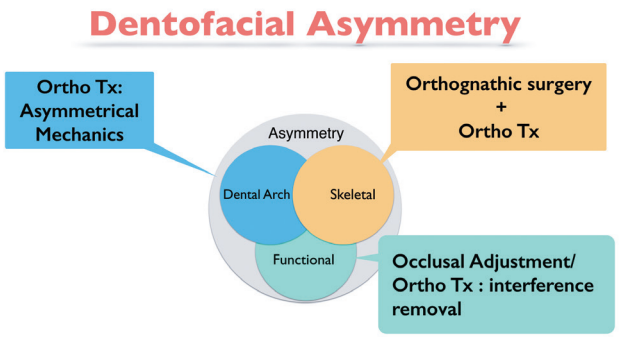


Fig. 25:
Dentofacial asymmetry is due to one or a combination of factors: dental arch, skeletal or functional. The usual treatment for each factor in the inner circle is shown in the adjacent box of the same color.

occlusion. In order to achieve a camouflage Class I occlusion, the maxillary arch was expanded and the mandibular arch was constricted. Asymmetrical space closure and opening mechanics often result in midline change.[16] In the maxillary arch, the space between the UR3 and UR6 was created to place an implant, whereas the extraction space of the ULb (*maxillary deciduous lateral incisor*) was closed. In the mandibular arch, the space between the LR4 and LR6 was eliminated. The differential closure of lower space benefited correction of the anterior crossbite by retracting the lower anterior teeth.

Implant Site Development

Implant site development usually requires bone formation in both the vertical and horizontal planes. In the vertical direction, orthodontic extrusion relocates the periodontal attachment in a coronal direction. In the horizontal plane, orthodontic movement forms bone as the alveolus is moved with the tooth. Bodily tooth movement is a viable option to bone grafting, particularly for atrophic edentulous sites associated with missing permanent teeth. Implant sites can be prepared in the anterior or posterior segments.[17-19]

Horizontal implant site development creates a significant amount of new bone that is stable in both the horizontal and vertical directions. Kokich[18] explored the dimensional ridge stability after canine retraction in subjects with congenitally missing maxillary lateral incisors. Twenty patients were followed for 5 years after opening upper lateral incisor spaces for implants and the loss of bone mass in the buccolingual dimension was less than 1%. Another report[19] evaluated bone loss in implant sites and found a mean width decrease of 4.2%, but the height decreased only slightly, about 0.07mm. For the present patient, the implant site was developed between two teeth (*UR3 and UR6*) which introduced the variables of tipping the incisors anteriorly and simultaneously retracting the molars. The 7.5mm space was opened slowly over 27 months (*Figs. 9 and 10*). The bone volume (*height 12.6mm x width 9mm*) was sufficient for a successful implant placement (*Figs. 12-15*).

Atherton's patch is a gingival depression that occurs as space is opened when the epithelial lining of a gingival sulcus is everted and repositioned on the crest of the alveolar ridge.[20,21] The red patch disappears spontaneously as the affected gingiva matures. During orthodontic site development,

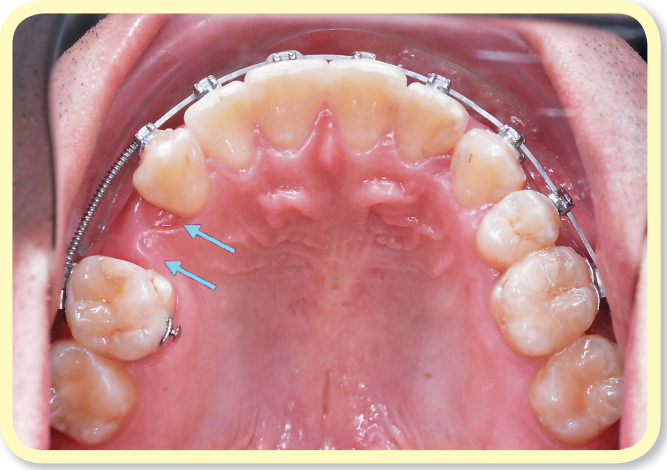


Fig. 26:
Two blue arrows show Atherton's patches. The patch distal to the UR3 is wider than the one on the mesial of the UR6 because the canine was moved furthest.

the interproximal papilla remains adjacent to the tooth that is not moving. Moving both the upper right canine and the upper right first molar results in Atherton's patches adjacent to both teeth. The patient was not concerned about this temporary esthetic problem because he was warned about it in advance.

To provide adequate space for implant placement, orthodontically generated implant sites require that roots of adjacent teeth be parallel or slightly divergent. Root positioning is a more complex problem for incisors that are tipped anteriorly because of the "*wagon-wheel effect.*"[22] The position of the roots should be evaluated radiographically before the fixed appliances are removed. For the present patient, a compressed open coil spring was used to create the space for the implant. A resin ball was added to the archwire between the brackets to reactivate the open coil spring.[23]

Fig. 27: One-year follow-up facial and intraoral photos document a stable outcome.

Conclusion

An acquired Class III malocclusion with six congenitally missing permanent teeth (*oligodontia*) was corrected with differential space management, Class III intermaxillary elastics, and bite turbos bonded on the posterior teeth. Asymmetric mechanics corrected the functional shift and midline discrepancy. The implant site was created with relatively slow space opening and the ISP was stable at one year follow-up.

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Discrepancy Index Worksheet

TOTAL D.I. SCORE 66

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 = 38

OVERBITE

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

Total = 3

ANTERIOR OPEN BITE

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

Total = 0

LATERAL OPEN BITE

2 pts. per mm. per tooth

Total = 0

CROWDING (only one arch)

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

Total = 1

OCCLUSION

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

Total = 2

LINGUAL POSTERIOR X-BITE

1 pt. per tooth Total = 0

BUCCAL POSTERIOR X-BITE

2 pts. per tooth Total = 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2° = 4 pts.

Each degree < -2° 3 x 1 pt. = 3

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

SN-MP

≥ 38° = 2 pts.

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

≤ 26° = 1 pt.

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

1 to MP ≥ 99° = 1 pt.

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

Total = 8

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. =	2
Missing teeth (except 3rd molars)	_____ x 1 pts. =	_____
Missing teeth, congenital	6 x 2 pts. =	12
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 = 14

Cast-Radiograph Evaluation

Case # **Patient**

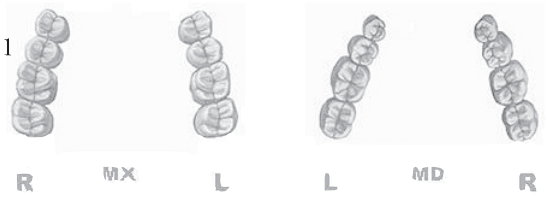
Total Score: 15

Alignment/Rotations

3

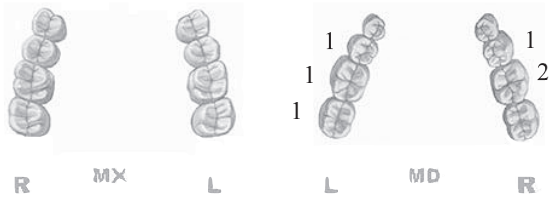
Marginal Ridges

1



Buccolingual Inclination

6

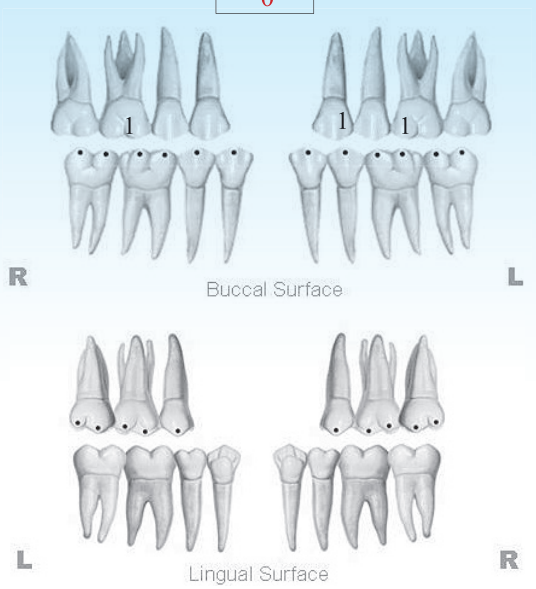


Overjet

0

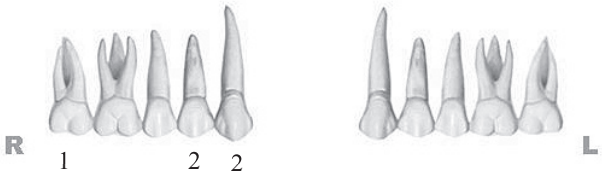
Occlusal Contacts

0



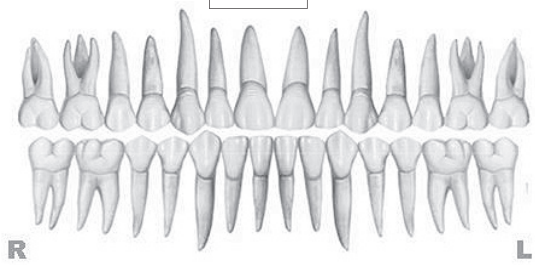
Occlusal Relationships

5



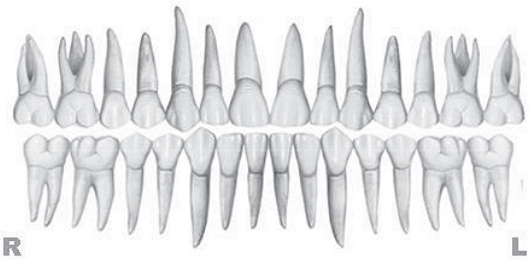
Interproximal Contacts

0



Root Angulation

0



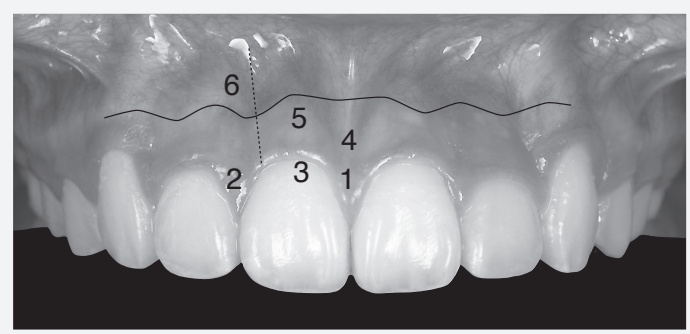
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

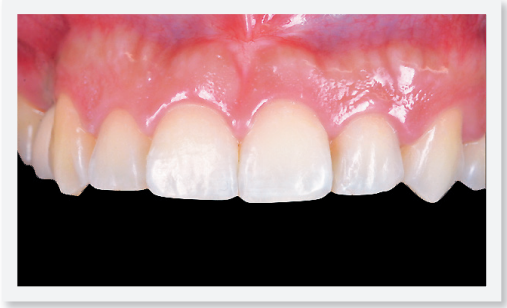
Total Score: = 4

1. Pink Esthetic Score

Total = 0



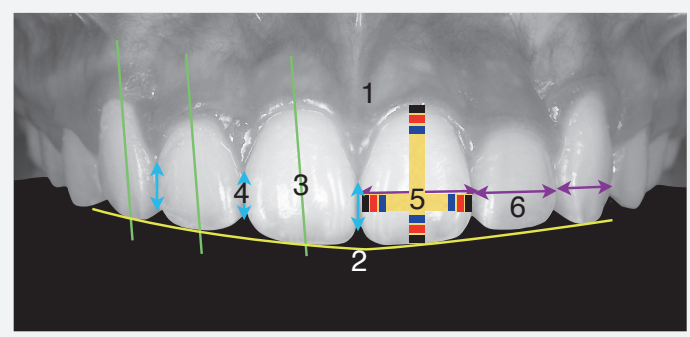
1. M & D Papillae	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival Margin	0	1	2
4. Level of Gingival Margin	0	1	2
5. Root Convexity (Torque)	0	1	2
6. Scar Formation	0	1	2



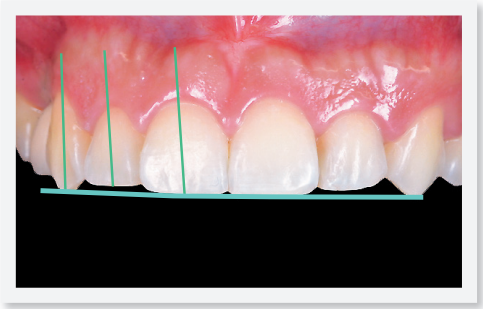
1. M & D Papilla	(0)	1	2
2. Keratinized Gingiva	(0)	1	2
3. Curvature of Gingival Margin	(0)	1	2
4. Level of Gingival Margin	(0)	1	2
5. Root Convexity (Torque)	(0)	1	2
6. Scar Formation	(0)	1	2

2. White Esthetic Score (for Micro-esthetics)

Total = 4



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