Surface-Treated Two-Component C-Implant: Revisited

2

Kyu-Rhim Chung, Yong Kim, and Seong-Hun Kim

Abstract

C-implant is a two-component orthodontic mini-implant with 1.8 mm diameter and 8.5 mm length. It is surface treated with sandblasting and acid etching to reduce implant failure. The head portion of the C-implant is detachable and functions as a buccal tube of a fixed appliance to allow archwire to pass through the hole in the head portion. Osseointegration of C-implants widened the clinical treatment modality by allowing multidirectional orthodontic force applications for intended orthodontic tooth movement. Rotation resistance increased the efficiency and efficacy of force control during orthodontic treatment. C-implant is especially useful for Biocreative Orthodontics, defined as independent en masse retraction of the anterior teeth while avoiding orthodontic appliances on the posterior segments during the retraction period. This alternative approach is beneficial in maximum anchorage cases that present with a poor dental health status such as severe dental caries, advanced periodontal disease, or missing posterior teeth.

C-implant was first introduced in 2000 and the design of the mini-implant has not been modified since then. Design of C-implant is similar to orthodontic miniscrews, and also it is analogous to the miniature version of endosseous implant. The difference of C-implant from orthodontic miniscrews is that it has been surface treated by sandblasting and acid etching to increase the bone to implant osseointegration potential. The similarity of the C-implant to endosseous implant is that it is composed of two separate parts: the screw part in the bone and head part in the oral cavity (Fig. 2.1). The screw part is 1.8 mm in diameter and 8.5, 9.5, 10.5 mm in length. The entire surface, except for the upper 2 mm, is sandblasted and acid etched (SLA) for optimal osseointegration because partial osseointegration reduces the risk of implant failure [1–3]. The head portion of the C-implant is detachable from the screw

K.-R. Chung, DMD, MSD, PhD
Division of Orthodontics, School of Medicine, Ajou University, Wonchun-dong 5, Youngtong-Ku, Suwon 443-380, South Korea
e-mail: speedor@hotmail.com

Y. Kim, DDS • S.-H. Kim, DDS, MSD, PhD (✉)
Department of Orthodontics, School of Dentistry, Kyung Hee University, #1 Hoegi-dong, Dongdaemun-gu, Seoul 130-701, South Korea
e-mail: yong_korea@hotmail.com; bravortho@gmail.com, bravortho@khu.ac.kr

K.B. Kim (ed.), *Temporary Skeletal Anchorage Devices*,
DOI 10.1007/978-3-642-55052-2_2,

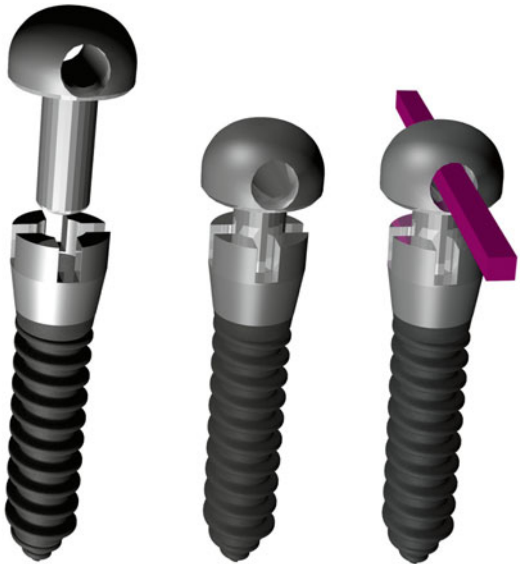

Fig. 2.1 The design of the C-implant

part. The head portion can function as a buccal tube of the fixed appliance that allows archwire to pass through the hole (0.08″ diameter) in the head portion (Fig. 2.2). The C-implant lacks self-drilling ability unlike orthodontic miniscrews, so manual drilling with driver is required before placing the C-implant. Before placing the screw part of the C-implant, pilot hole is drilled through the gingiva into the bone to guide direction of the C-implant. A 1.5-mm-diameter guide hand drill is connected to the screw handle. The pointed tip of the drill permits manual screwing. Lastly, the head portion is tapped into lock in the screw part.

The C-implant opened up new paradigm of skeletal anchorage in orthodontic treatment. The osseointegration potential has been studied clinically and histologically. Moreover, the survival rate and the clinical applications of C-implants were reported, and these generated changes in orthodontic treatment modalities. First, the SLA-treated C-implants were proved

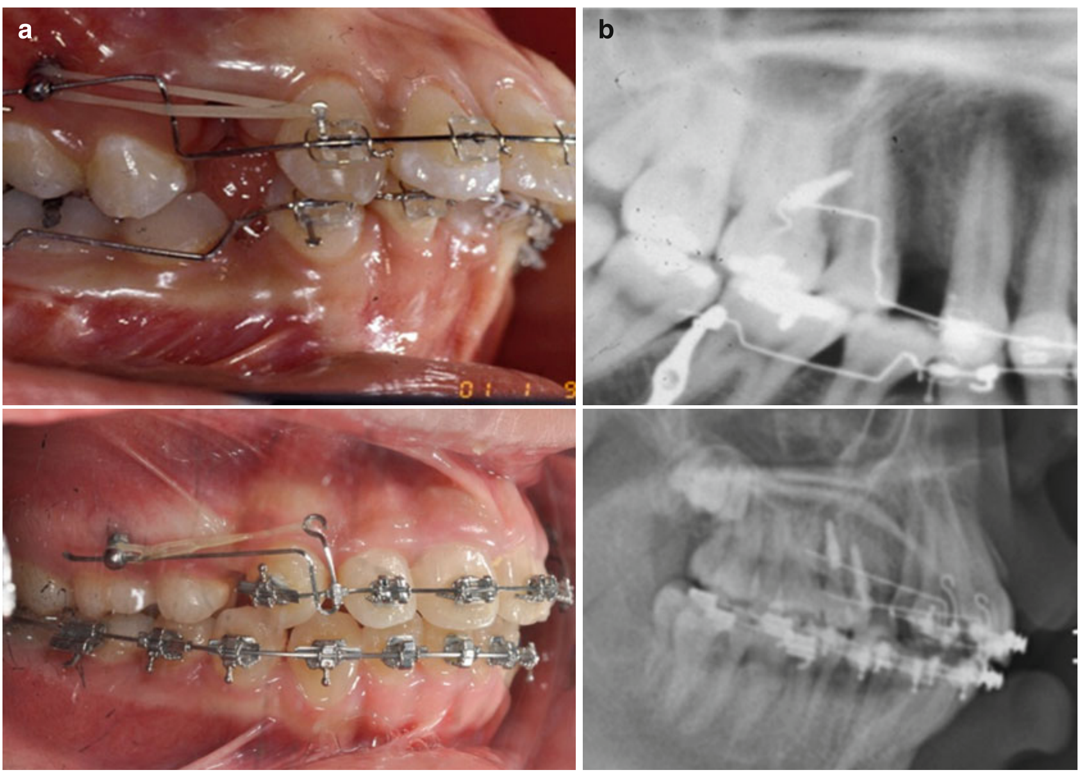

Fig. 2.2 Clinical (**a**) and radiographic (**b**) pictures demonstrating the wire insertion at the head part of the C-implant

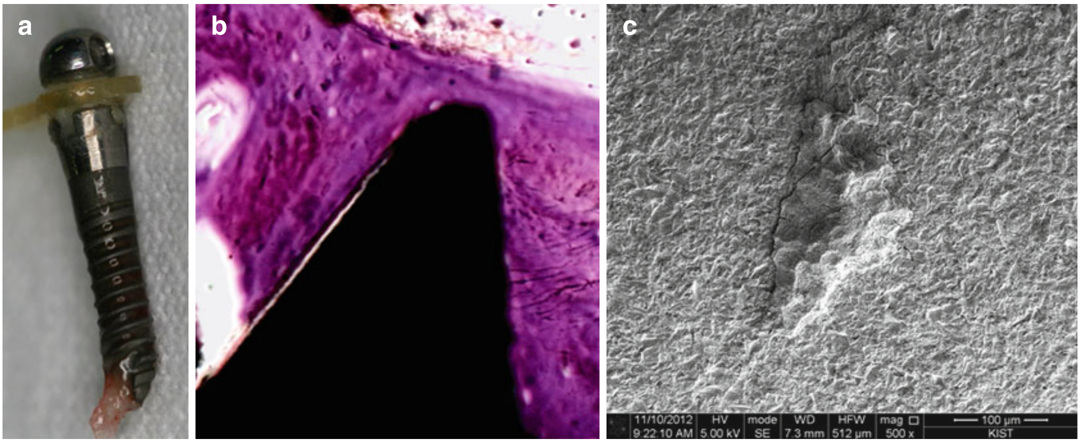

Fig. 2.3 (**a**) Showing the visible alveolar bone attachment upon C-implant removal. (**b**) SEM image demonstrating the intimate osseointegration between thread and bone. (**c**) TEM image

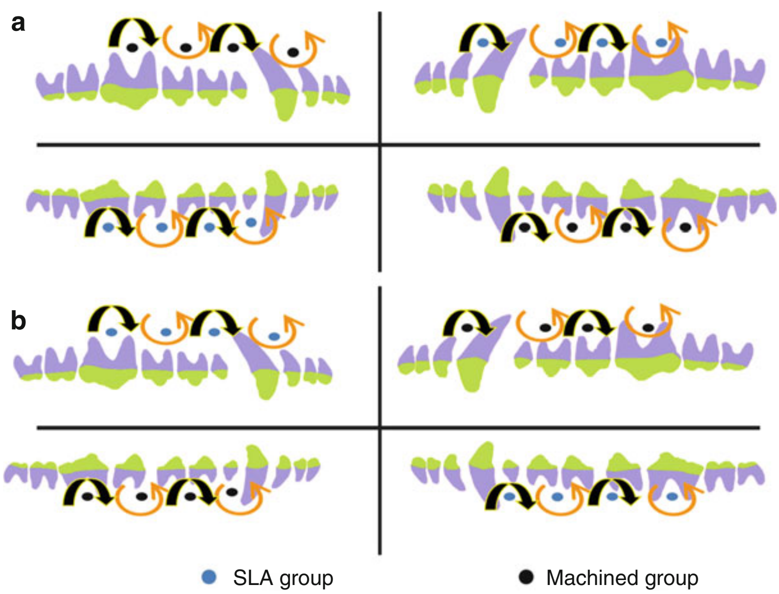

Fig. 2.4 Animal study comparing the machined miniscrews and SLA-treated miniscrews on rotational force and the removal toque value experiment. (**a**) Machined group, (**b**) SLA-treated group

to have osseointegration with the bone (Fig. 2.3). As a measurement of osseointegration potential and related stability of miniscrews, the removal torque values (RTV) of C-implants were studied by Kim et al. to compare the difference in RTV between machined and SLA-treated (C-implant) miniscrews on clockwise and counterclockwise force application on experimental animal model (Figs. 2.4 and 2.5) [4]. Also, it was proved to have increased RTV with longer duration of C-implant placement [5]. There have been debates whether miniscrews remain absolute skeletal anchorage or not with applied orthodontic forces. The positional stability of C-implants was examined with superimposition of the CBCT images, and the result clarified that the C-implants remained absolutely stationary [6]. So, C-implants remain stationary through treatment and, as a result, resist multidirectional orthodontic forces. Since the osseointegrated endosseous prosthetic implant has known to have positional stability, the finding from the CBCT study implies the osseointegration of C-implants. In recent study of Lee et al. on survival rate of the C-implant, they found that

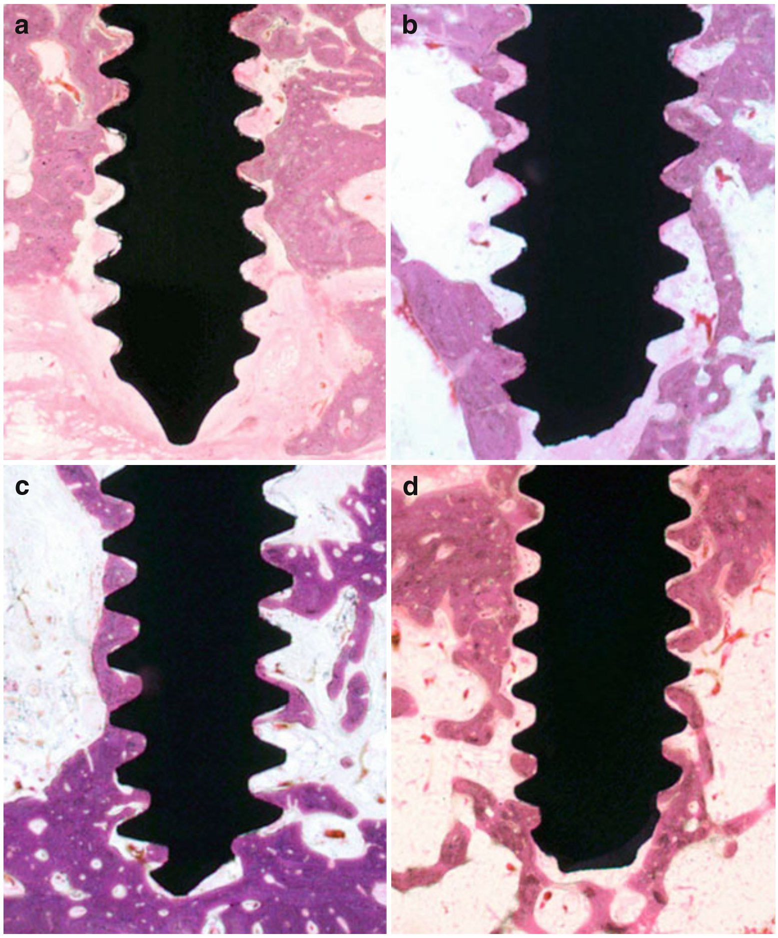

Fig. 2.5 (**a**) Machined clockwise rotational force. (**b**) Machined counterclockwise rotational force. (**c**) SLA-treated clockwise rotational force. (**d**) SLA-treated counterclockwise rotational force. Histological images showing osseointegration of both machined and SLA-treated miniscrews

the decrease in hazard function can successfully suggest the osseointegration of the orthodontic C-implants [7]. Lastly, in the backscatter SEM examination of the removed C-implants, the direct bone attachment to the implant surface was identified [8].

Osseointegration of C-implants widened clinical treatment modality by allowing multidirectional orthodontic force applications for intended orthodontic tooth movement. Rotation resistance increased the efficiency and efficacy of force control during orthodontic treatment. Biocreative Orthodontics Strategy (BO) is based on the ability of osseointegrated absolute skeletal anchorage control with C-implant. Ideal patient selections for Biocreative Orthodontics treatment are those who have stable posterior occlusion with anterior crowding with lip protrusion. Without altering the posterior occlusion, BO uses skeletal anchorage for en masse retraction without posterior dental anchorage support. The example of the Biocreative treatment is described below:

A 24-year-old woman presented with the chief complaints of lip protrusion and crowding (Fig. 2.6). Her prior medical and dental history revealed no significant systemic problems and absence of significant temporomandibular joint disorders. The initial clinical findings showed a convex facial profile associated with a retrognathic mandible and protrusive lips. The patient had a large overjet (6.0 mm) and significant amount of crowding in both arches (maxilla 20.0 mm; mandible 11.0 mm). The patient had class I molar relationship with the dental midline of lower arch deviated 4.0 mm to the right relative to the facial midline. Cephalometric analysis indicated a skeletal Class

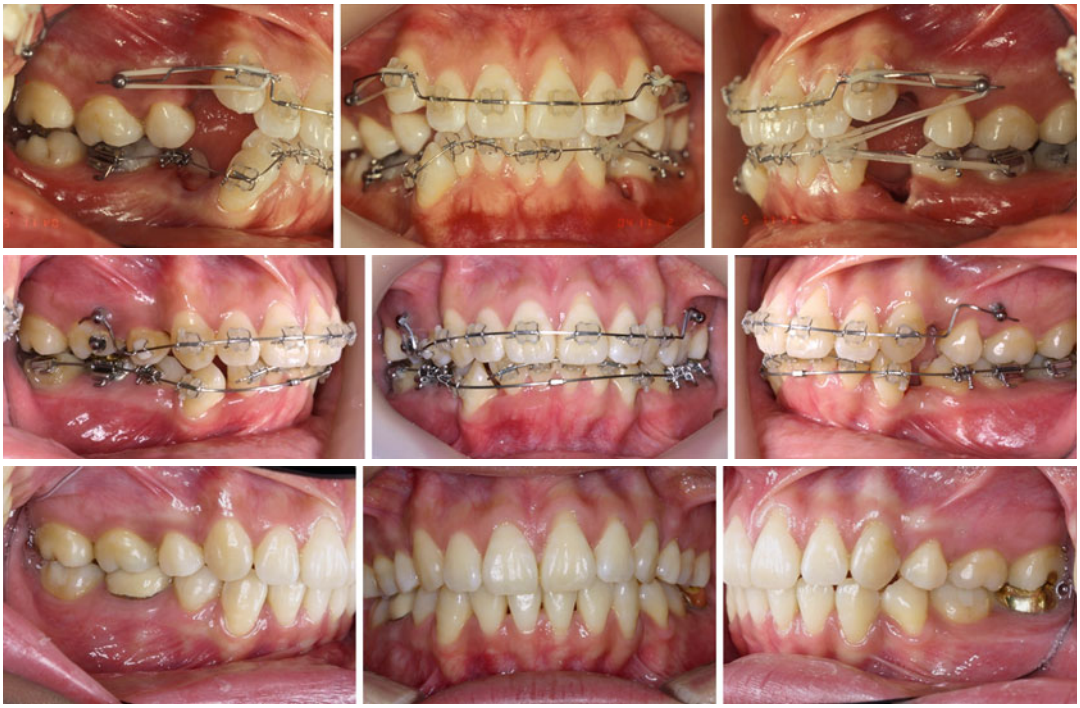

Fig. 2.6 Case treated with two C-implants in the maxillary arch with Biocreative Orthodontics Strategy

II, a hyperdivergent profile with steep mandibular plane angle, and upright maxillary and mandibular incisors. The patient was diagnosed with skeletal Class II protrusion with severe crowding.

Four first premolars were extracted. Two C-implants were placed between the second premolar and first molar in the maxilla. Brackets were bonded only on six anterior teeth in the maxilla during the initial stage of en masse retraction. Upper archwire was bent upward from distal of canines to pass through the head portion of the C-implant. Retraction of six anterior teeth and correction of the midline were performed by elastics. Class III elastic was placed between the maxillary C-implant and lower canine in the right side. When the extraction space was almost closed on the right side, the bracket was bonded on the upper second premolar and the button was bonded on the upper first molar. For detailing, brackets were bonded on all remaining teeth. At the completion of the treatment, soft tissue profile was dramatically improved. Panoramic x-ray revealed acceptable root parallelism without any other complications.

With C-implants, intrusive force can be created from resistance to rotation. The application of intrusive force is described using mousetrap appliance for molar intrusion (Figs. 2.7, 2.8, and 2.9).

In a patient who needed minor tooth movement for molar intrusion, two C-implants were placed between the second premolar and molar in the buccal and palatal areas. Mousetrap appliance made with TMA archwire is held in the occlusal surface of the molar for intrusion, and 150–300 g of intrusive force is immediately applied. Osseointegration of the C-implant resists the rotational force and is converted into the intrusive force, which then is applied to the molar to intrude the palatal cusp. Because C-implant was identified to be osseointegrated into the bone, the mousetrap appliance can be successfully used with the assurance of resistance to rotational force created by intrusion.

Furthermore, the C-implant can be used in general dentistry as a provisional implant due to the proof of osseointegration. The C-implant design is analogous to endosseous prosthetic implant with the screw part and head part and

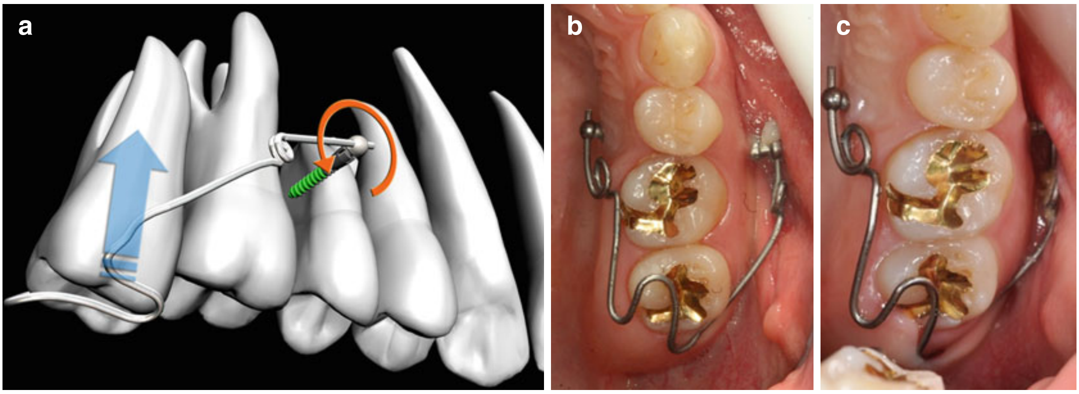

Fig. 2.7 (**a**) Mousetrap appliance diagram illustrating the conversion of rotational force to intrusive force. (**b**) Clinical picture of mousetrap appliance for intrusion of the maxillary second molar. (**c**) The intrusion of the maxillary second molar shown

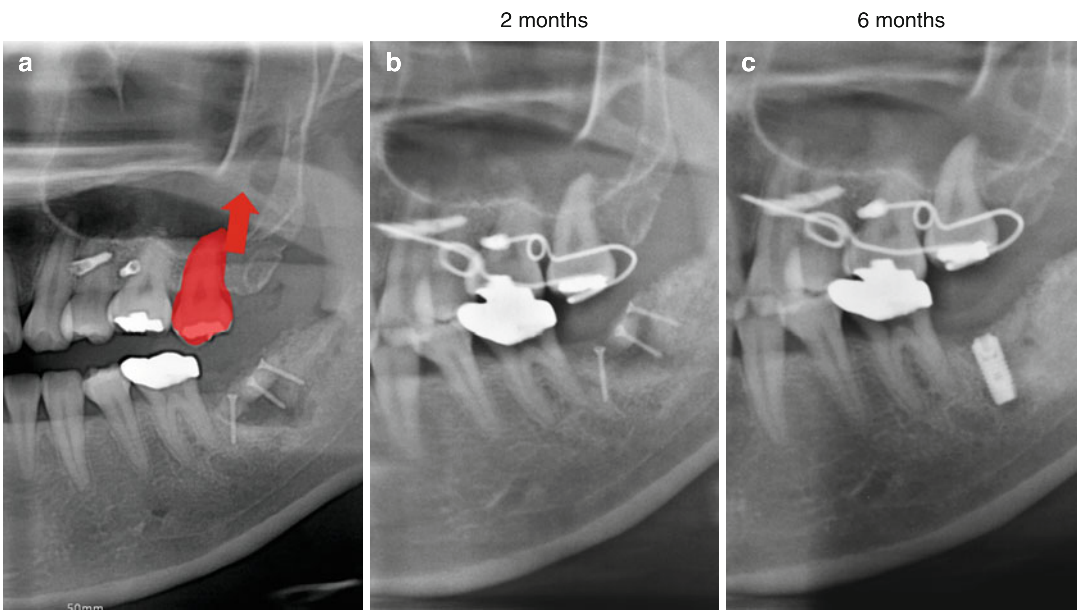

Fig. 2.8 (**a**) Illustrating the expected result of the mousetrap appliance. (**b**) Two months of application shows intruded second maxillary molar. (**c**) After 6 months of the mousetrap appliance, maxillary second molar intrusion is completed without any complication and the space for the opposing implant site is prepared

used for provisional implant system (Figs. 2.10 and 2.11). The head part can be replaced with implant custom-made abutment and tapped into the endosseous screw part. The provisional crown can be fabricated to evaluate the function and esthetic of the final implant crown. It is useful in growing child to maintain space, to function as a provisional crown, and to enhance esthetics until the termination of growth for the future recipient of endosseous implant. If in case of the limited edentulous space for the endosseous implant, the C-implant can act as replacement of choice.

Here are case presentations of the C-implants applied in orthodontic treatment.

Case 1 (Figs. 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.18, and 2.19)

A 12-year-old male presented at the orthodontic department of Kyung Hee University with the chief complaint of protrusive lips.

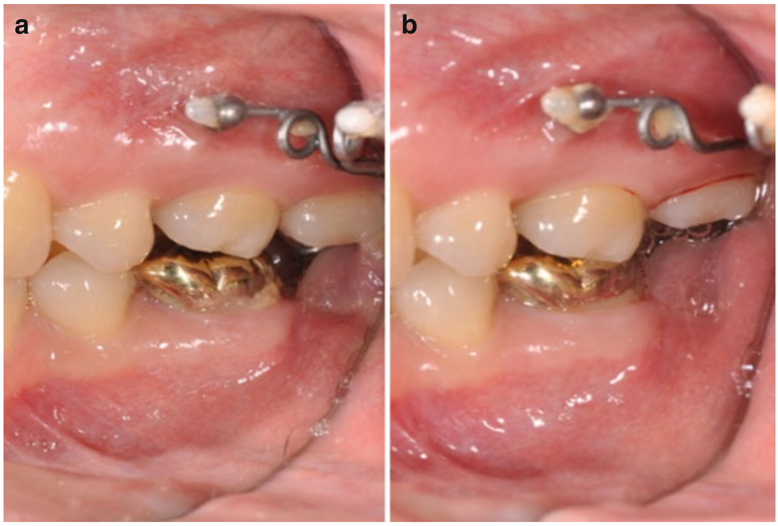

Fig. 2.9 Clinical pictures showing the initial (**a**) and final (**b**)

Fig. 2.10 C-implants working as a provisional implant fixture and custom-made abutment illustrated on the *upper row*. The finished provisional implant crown in place shows esthetic result in the *bottom row*

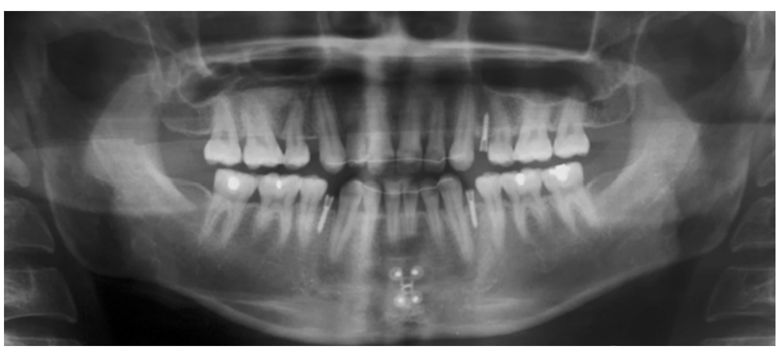

Fig. 2.11 The panoramic radiograph with three C-implants placement without custom abutment and crown portion

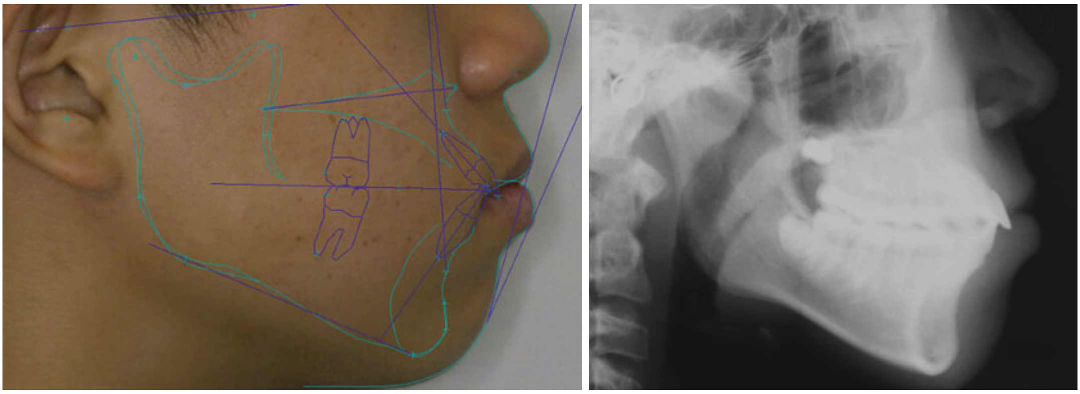

Fig. 2.12 Case 1 of Biocreative treatment. Lateral facial photograph with lateral cephalometric tracing and lateral cephalogram

Fig. 2.13 Right maxillary C-implant placement between the second premolar and first molar with upper and lower right first premolar extraction. Notice Class I molar relationship in both right and left sides

Clinical examination showed a convex profile, incompetent lips with incisal exposure of 5 mm at rest, decreased nasolabial angle, deep labiomental sulcus, and normal lower facial height. Intraoral examination revealed Class I molar and Class II canine relationship, with an overjet of 6 mm and an overbite of 2 mm (Fig. 2.12). All third molars were not erupted. The patient had proclined upper and lower incisors. There were no signs of TMJ problems. Cephalometric analysis indicated dentoalveolar bimaxillary protrusion. The treatment objectives were to reduce the lip protrusion and improve the soft tissue esthetics and correct the axial inclinations of the anterior teeth. These objectives could be achieved by retracting the upper and lower anterior teeth with maximum anchorage after extraction of the four first premolars. Extracting the four first premolars was expected to offer the greatest potential for retraction of the anteriors. Other extraction combinations would not provide as much improvement on the soft tissue profile [9].

Fig. 2.14 Intraoral photographs of the progression in en masse maxillary retraction demonstrate progression of extraction space closure. Conventional treatment is progressing in the lower arch

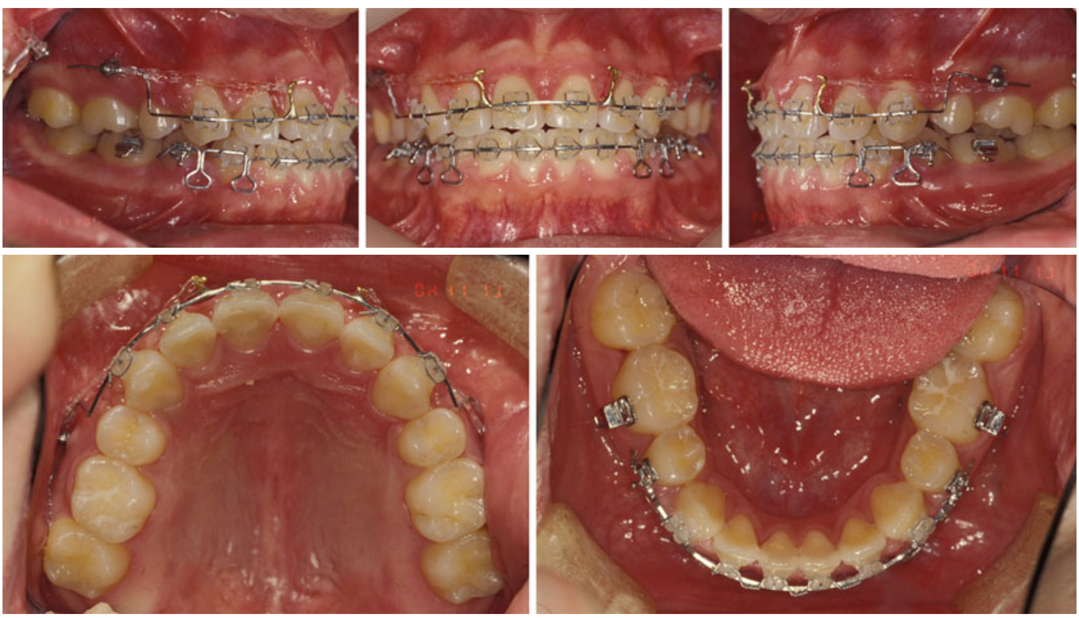

Fig. 2.15 Completed space closure of the extraction space on upper and lower dentition in 9 months

Three treatment options were explained. (1) Use headgear as an extraoral anchorage, (2) use miniscrews as anchorage to reinforce the bonded or banded posterior anchorage teeth during anterior retraction, or (3) use miniscrews as an independent appliance for anterior retraction without placing posterior fixed appliances in the maxilla. The patient and his parents opted

Fig. 2.16 Complete debonding of upper and lower arches and bonding of the fixed lingual retainer in upper and lower arches

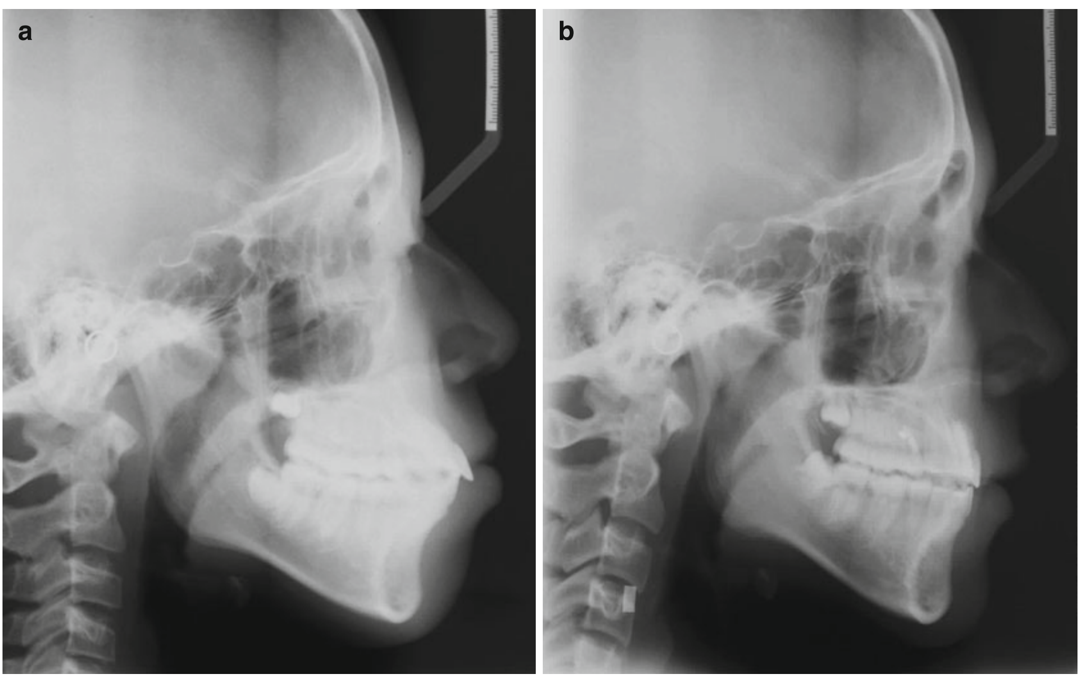

Fig. 2.17 The initial lateral cephalogram (**a**) and the final lateral cephalogram (**b**). Notice the improved facial profile with retruded upper and lower lips

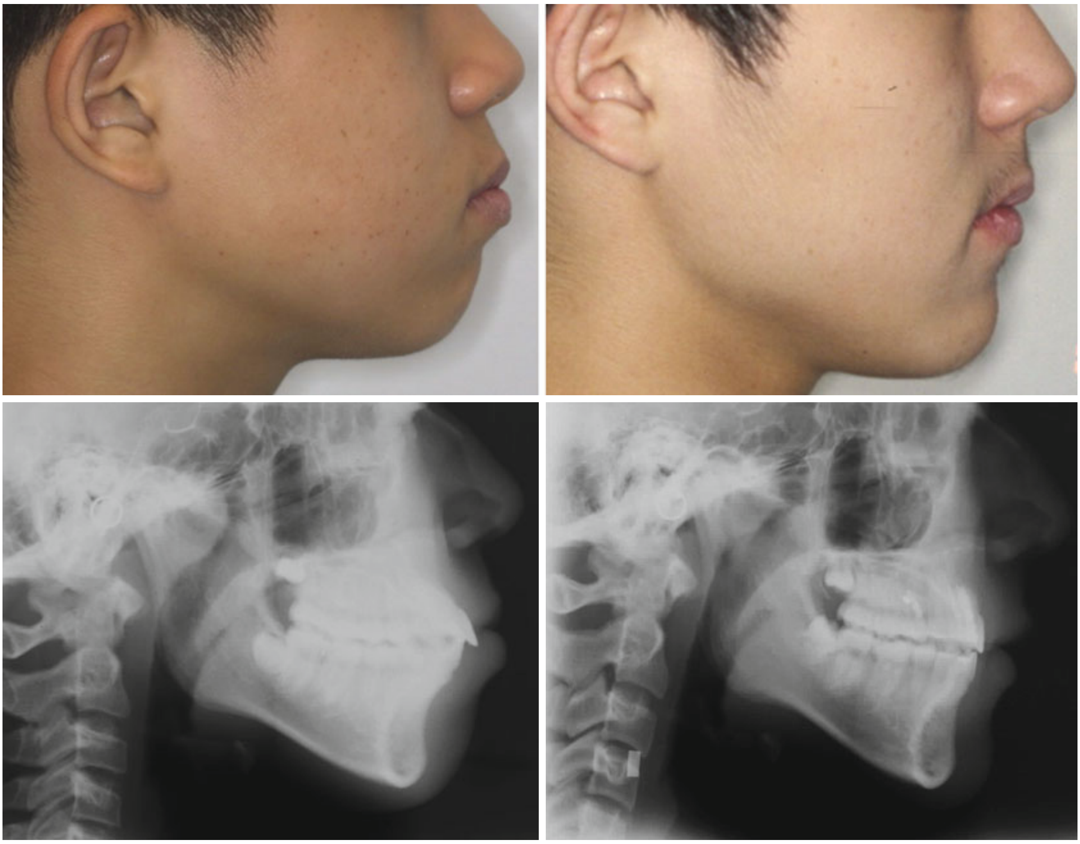

Fig. 2.18 The lateral facial photographs showing the initial (**a**) and final (**b**) profile improvement in lip protrusion, nasolabial angle, and submental sulcus

for the third treatment option. This plan allowed maximum retraction of the upper anterior teeth without disturbing molar occlusal relationships and minimizing stress on the periodontium. This treatment protocol is called “Biocreative Orthodontics,” defined as independent en masse retraction of the anterior teeth while avoiding orthodontic appliances on the posterior segments during the retraction period [10, 11]. This alternative approach, which uses partially osseointegrated mini-implants or miniplates to resist multidirectional heavy orthodontic forces, can be beneficial in maximum anchorage cases that present with a poor dental health status such as severe dental caries, advanced periodontal disease, or missing posterior teeth. The aim of Biocreative Orthodontics is to consider this segment as a whole and apply careful torque control during retraction.

Two C-implants were placed in the interradicular space between the upper second premolars and first molars on each side and it was started on the right side first (Fig. 2.13). Four first premolars were extracted. Brackets were bonded on six anterior teeth in the maxilla and from the central incisor to the first molar in the mandible. Upper archwire was bent from distal of canines to pass through the head portion of the C-implant. After preliminary alignment was obtained, 0.018″ stainless steel archwires were placed. Elastics were placed from C-implant to extension hooks of canines and lateral incisors to retract six anterior teeth (Fig. 2.14).

Space closure was completed in 9 months (Fig. 2.15) and brackets were debonded (Fig. 2.16). Posttreatment cephalometric analysis revealed significant amount of incisor retraction by controlled tipping and excellent maintenance of

Fig. 2.19 Five-year retention of the same patient shows stable occlusion and ideal overbite and overjet in Class I relationship

molar occlusal relationship (Fig. 2.17). Patient's profile was considerably improved. Soft tissue objectives were met by achieving a significant reduction in the lip protrusion (Fig. 2.18). Treatment result remained stable 5 years after debonding (Fig. 2.19).

Case 2 (Figs. 2.20, 2.21, 2.22, 2.23, 2.24, 2.25, 2.26, and 2.27)

A 30-year-old female visited our department with chief complaint of "crooked front teeth" (Fig. 2.20). Her prior medical and dental history revealed no significant systemic problems and no significant temporomandibular joint disorders. The patient had straight facial profile with long lower facial height and acute nasolabial angle. Intraoral examination showed Class I molar and canine relationship with moderate crowding on both arches. All four wisdom teeth were absent. Cephalometric analysis revealed skeletal Class II with steep mandibular plane (Fig. 2.21). The treatment objectives were to resolve crowding without influencing soft tissue profile. Considering patient's straight facial profile, extraction was excluded. Molar distalization was planned to resolve crowding.

In the maxilla, retraction force was applied by C-palatal plate[1] (temporary skeletal anchorage

[1] C-palatal plate: Alternative treatment of choice instead of miniscrews for guarded periodontal health patients. Push and pull mechanics are possible.

Fig. 2.20 Initial photographs of Case 2 patient showing the anterior crowding and arch length discrepancy but stable posterior occlusion

devices) in the palatal side and open coil spring on the buccal side. In the mandible, distalizing force was applied by open coil spring connected between C-implants and extension hook of the first molar. Two C-implants were placed between the first and second premolars on each side of the mandible (Figs. 2.22 and 2.23). With palatal C-plate and two C-implants, distalization of posterior segments was achieved first, and with gained space, anterior crowding was resolved (Figs. 2.24 and 2.25). After leveling and aligning with conventional brackets on the upper and lower arches, brackets were debonded (Fig. 2.26). Final lateral cephalogram shows no change in soft tissue profile with achievement of the treatment plan, and panoramic radiograph shows satisfying root parallelism (Fig. 2.27).

The C-implants can be further studied in studying the nanoscale examination of bone to implant osseointegrated interface. In the recent study of Kang [8], the implant interface under SEM and TEM analysis, there was intimate surface contact between the bone and implant interface surfaces. Further detailed investigation to find the chemical composition and histotopography of the interface is expected. Also, using the clinical data of C-implants, the failure of dental prosthetic implant can be referred.

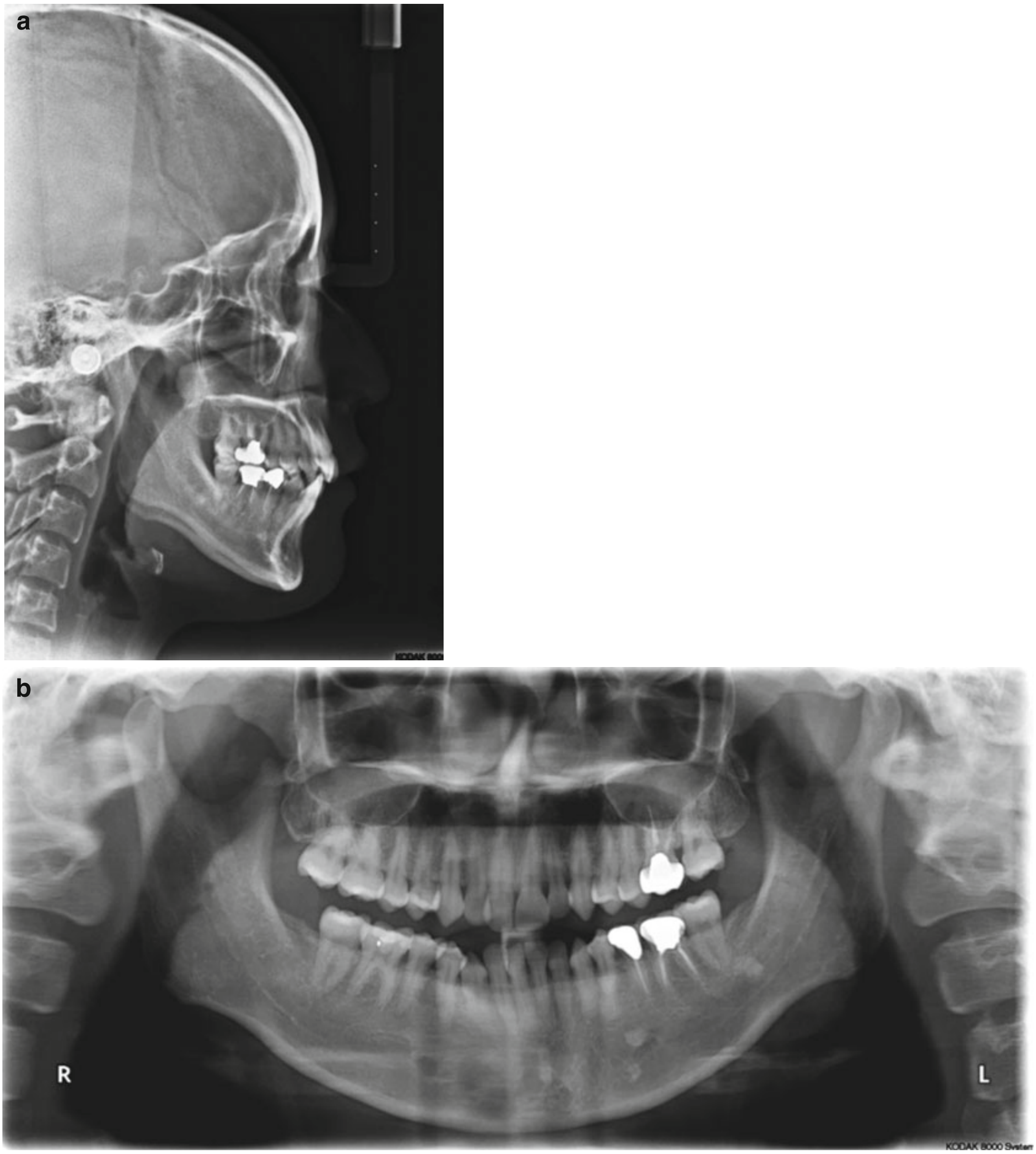

Fig. 2.21 Initial lateral cephalogram (**a**) and panoramic radiograph (**b**)

Fig. 2.22 On maxillary arch, palatal C-plate is retracting the transpalatal arch connecting premolars on the palatal side and the open coil springs are pushing the second molars. In the mandible, the C-implants are placed between the first and second premolars and are connected to the posterior segments with extended hook. Open coil springs are pushing the posterior segments with open coil springs from C-implants

Fig. 2.23 The magnified views of the C-implants demonstrating the pushing mechanics

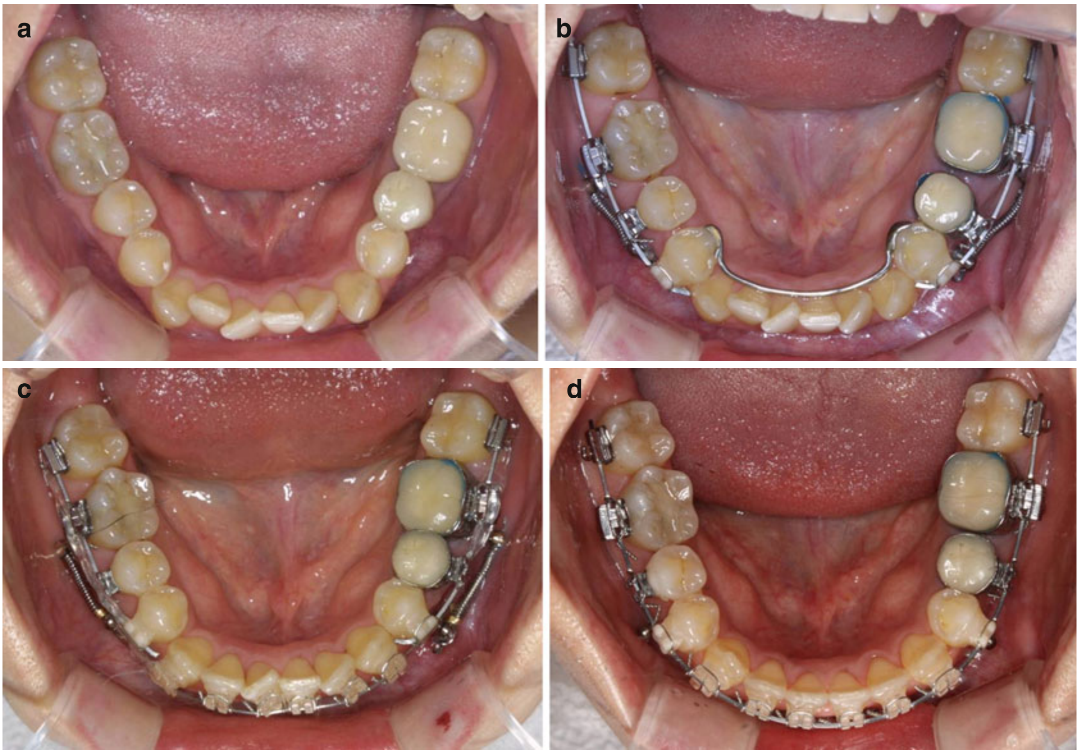

Fig. 2.24 Sequential (**a**–**d**) mandibular intraoral photographs showing the distalization of posterior segments and decrowding of the anterior dentition

Fig. 2.25 Sequential (**a**–**d**) maxillary intraoral photographs showing the distalization of posterior segments and decrowding of the anterior dentition

Fig. 2.26 Final intraoral photographs after debonding

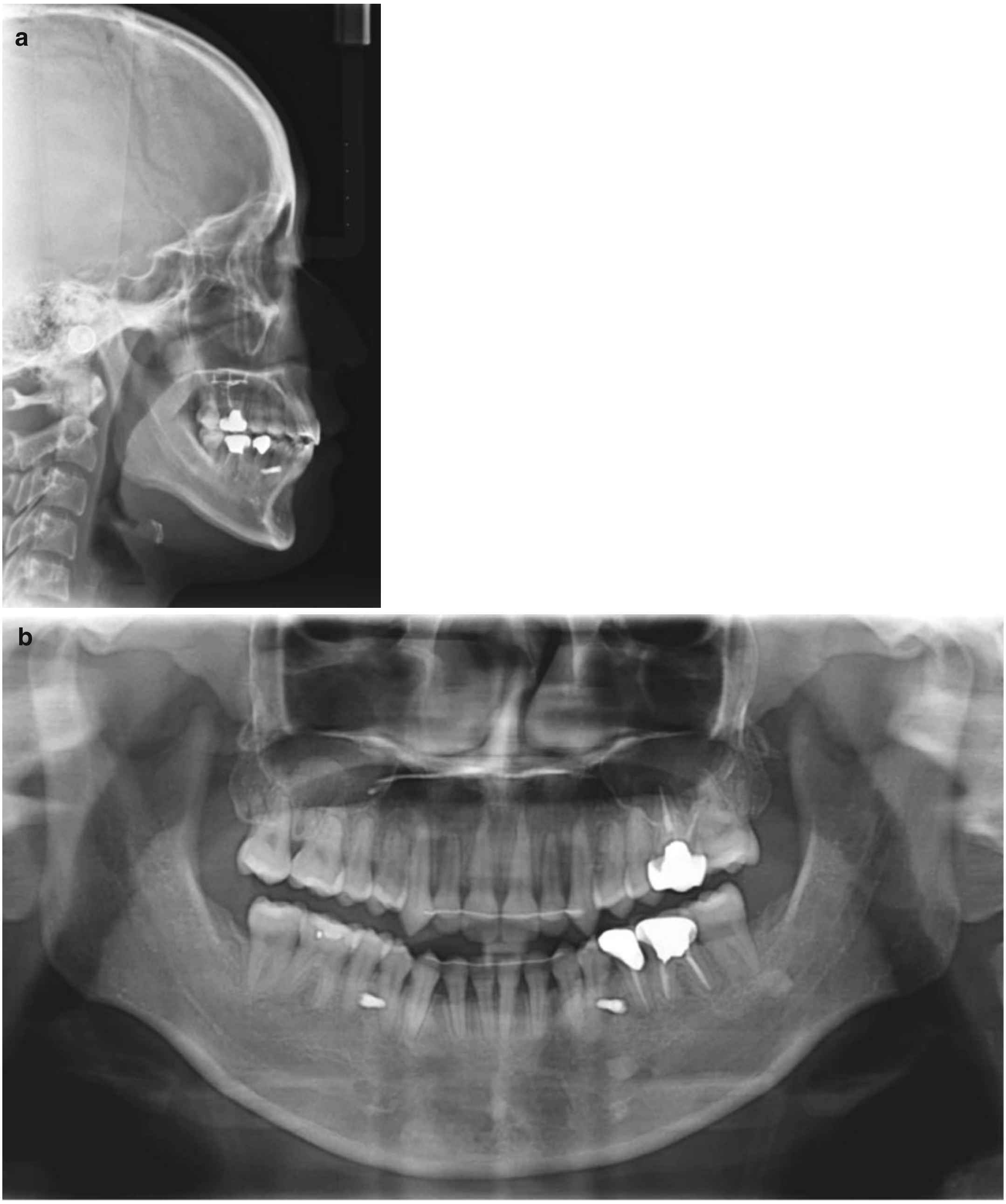

Fig. 2.27 Final lateral cephalogram (**a**) and panoramic radiograph (**b**)

Acknowledgment The authors thank Dr. Kyung Won Seo, postgraduate student of Kyung Hee University School of Dentistry, for manuscript editing.

References

1. Lee S, Chung K. The effect of early loading on the direct bone-to-implant surface contact of the orthodontic osseointegrated titanium implant. Korean J Orthod. 2001;31:173–85.
2. Chung K-R, Kim S-H, Kook Y-A. The C-orthodontic micro-implant. J Clin Orthod. 2004;38(9):478–86, quiz 487–8.
3. Chung K-R, Nelson G, Kim S-H, Kook Y-A. Severe bidentoalveolar protrusion treated with orthodontic microimplant-dependent en-masse retraction. Am J Orthod Dentofacial Orthop. 2007;132(1):105–15.
4. Kim S-H, Lee S-J, Cho I-S, Kim S-K, Kim T-W. Rotational resistance of surface-treated mini-implants. Angle Orthod. 2009;79(5):899–907.
5. Kim S-H, Cho J-H, Chung K-R, Kook Y-A, Nelson G. Removal torque values of surface-treated mini-implants after loading. Am J Orthod Dentofacial Orthop. 2008;134(1):36–43.
6. Kim S-H, Choi J-H, Chung K-R, Nelson G. Do sand blasted with large grit and acid etched surface treated mini-implants remain stationary under orthodontic forces? Angle Orthod. 2012;82(2):304–12.
7. Lee S-J, Lin L, Kim S-H, Chung K-R, Donatelli RE. Survival analysis of a miniplate and tube device designed to provide skeletal anchorage. Am J Orthod Dentofacial Orthop. 2013;144(3):349–56.
8. Kang S-M. Cryo-Transmission electron microscopy evaluation of interface of orthodontic implant surface and cortical bone in human patients [PhD thesis]. Seoul: Kyung Hee University; 2013.
9. Bills DA, Handelman CS, BeGole EA. Bimaxillary dentoalveolar protrusion: traits and orthodontic correction. Angle Orthod. 2005;75(3):333–9.
10. Chung K-R, Kook Y-A, Kim S-H, Mo S-S, Jung J-A. Class II malocclusion treated by combining a lingual retractor and a palatal plate. Am J Orthod Dentofacial Orthop. 2008;133(1):112–23.
11. Kim S-H, Hwang Y-S, Ferreira A, Chung K-R. Analysis of temporary skeletal anchorage devices used for en-masse retraction: a preliminary study. Am J Orthod Dentofacial Orthop. 2009;136(2): 268–76.

http://www.springer.com/978-3-642-55051-5

Temporary Skeletal Anchorage Devices
A Guide to Design and Evidence-Based Solution
Kim, K.B. (Ed.)
2014, XI, 233 p. 183 illus., 158 illus. in color., Hardcover
ISBN: 978-3-642-55051-5