Novel application of the 2-piece orthodontic C-implant for temporary crown restoration after orthodontic treatment

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Introduction: This article reports the use of an orthodontic mini-implant for a temporary crown restoration in a small edentulous space after limited orthodontic treatment. Methods: Two clinical cases are presented: a 23-year-old woman and a 14-year-old boy. In the adult patient, a 2-piece orthodontic C-implant (Cimplant, Seoul, Korea) was placed in a 3-mm wide edentulous space to build up a temporary crown restoration after a short orthodontic treatment to regain space for a missing mandibular right permanent lateral incisor. In the boy, a C-implant was placed in the space resulting from an avulsed maxillary right permanent lateral incisor to prevent aggressive alveolar bone resorption after dental trauma. Both patients were followed for more than 4 years of retention to evaluate the stability of the temporary crown restoration built up on the orthodontic mini-implants. Results: Both patients had successful long-term results, confirmed by clinical and radiographic examinations. Both were pleased with the results and plan to retain the orthodontic mini-implant temporary crown restoration until they are ready for a permanent restoration later. Conclusions: A 2-piece orthodontic C-implant system can be used to maintain edentulous space after active orthodontic treatment. (Am J Orthod Dentofacial Orthop 2011;140:569-79)

The C-implant (Cimplant, Seoul, Korea) is a 2-piece orthodontic mini-implant system developed by Dr Kyu-Rhim Chung in Korea in 2000; its clinical application as a temporary skeletal anchorage device has been reported [Fig 1].1-4 The unique biomechanics of this system overcome many limitations encountered in conventional orthodontic therapy.5-7 The characteristics of the C-implant as an orthodontic skeletal anchorage device resemble Bränemark’s standard restorative dental implant system developed in 1951.8 Dental implant systems are currently accepted as the treatment of choice for permanent restoration of an edentulous area of a single tooth in contemporary restorative dentistry. Various dental implant systems have been introduced through years of design modifications regarding shape, diameter, length, surface treatment methods, connection types, and so forth for different clinical conditions.9-11

The Bolton ratio discrepancy and congenitally missing permanent teeth are common clinical findings during the initial diagnoses of orthodontic patients. If the goal of active orthodontic treatment is to regain and restore the lost space, the conventional space maintenance option is either a Maryland bridge or a removable retainer with a pontic. Most patients prefer the cemented Maryland bridge appliance. However, the drawback of this treatment option includes inevitable permanent damage of the adjacent natural tooth structures. In addition, it does not accommodate transverse dimensional changes of the dentition during the posttreatment retention period.

Therefore, as an alternative to the Maryland bridge, a single-tooth mini-implant has been reported to serve as an abutment for a crown restoration with a long-term retention period.12 Also, a self-drilling 1-piece
orthodontic miniscrew can be used for temporary abutment. However, this miniscrew can, at most, be used as a space maintainer with no capability of esthetic restoration for the edentulous area during the posttreatment retention period because of its limited head design. It cannot provide enough stability to endure occlusal forces on an esthetically restored temporary crown. This might be because most 1-piece orthodontic miniscrews do not have a surface treatment that encourages osseointegration between the mini-implant and the bone. In addition, esthetic temporary crown buildups can be difficult to do with a 1-piece orthodontic miniscrew design. Driven by necessity for these orthodontic patients, minitype restorative dental implants have recently been developed in periodontics and prosthodontics as a novel treatment option for a fixed-type temporary crown restoration for the residual space after orthodontic treatment.13-16 The interdisciplinary treatment approach for temporary crown restoration at the end of the orthodontic treatment can sometimes be cumbersome to the patient with extra costs and visits to various clinics; this might delay completion of orthodontic treatment.

In such instances, an orthodontic 2-piece mini-implant can be an easy in-office solution that would eliminate the need for interdisciplinary referrals. The dimension and design of a C-implant make it an ideal size abutment for any small orthodontic edentulous area. The C-implant also facilitates the esthetic fabrication of a temporary crown by using the indirect buildup method (Fig 1, B and C). In addition, the sand-blasted with large grit and acid-etched (SLA) treated surface of the C-implant body promotes osseointegration and makes the C-implant–based temporary crown an ideal treatment when the alveolar bone of the edentulous area is at risk of further resorption.16-19 In cases of dental trauma such as complete tooth avulsion or lost teeth, it is recommended to place a C-implant within the first 3 months after the dental accident and subsequent wound healing.

The standard dimensions of a C-implant used for temporary crown restoration are 10.5 mm in length and 1.8 mm in diameter. The length of the mini-implant body used for temporary restorations is much longer than that used for orthodontic anchorage. The surface of the C-implant body is SLA treated to increase the degree of osseointegration between the bone and the mini-implant. The C-implant body connects with its head part by a friction-grip joint. Although 3 lengths of the head part are available (1, 2, and 3 mm), the 3-mm head is usually recommended when the C-implant is used for temporary crown restorations.

The closed method (Figs 2 and 3) does not require an incision for a periodontal flap operation. This technique is indicated when the full width of the alveolar crest is intact with palpation. After local anesthesia, a tissue punch marks the implant placement point, and the 1500-rpm straight low-speed handpiece drills a pilot hole under isotonic saline-solution irrigation. The 1.5-mm diameter guide drill (Stryker Leibinger, Freiburg, Germany) is designed to penetrate the single cortical wall and therefore has minimum risk of dental root damage. A 1.8-mm diameter C-implant body is then screwed into the drilled hole with a manual driver.

If the alveolar bone crest is buccolingually resorbed after active orthodontic treatment regaining space, it is recommended to place the C-implant body with the open method (Fig 4) with a periodontal flap. The actual anatomy of the lateral alveolar crest walls might differ from the overlying gingival tissues. A gingival flap incision is made by using a number 15 blade, followed by determination of the position and direction of the C-implant body placement (Fig 4, A and B). The mucosal depth of the alveolar crest determines the size of the C-implant head attachment. The temporary crown is created 6 to 8 weeks after placement of the C-implant body to avoid unnecessary loading and gingival

**Fig 1.** A, Schematic illustration of 2-component titanium C-implant for prosthodontic use; B, periapical radiograph before provisional C-implant application; C, periapical radiograph after provisional C-implant application.
irritation. A 3-mm head is effective in helping the sutured area heal without a second surgery to build the temporary crown restoration above the mini-implant body.

For 6 to 8 weeks after placement of the C-implant body, the edentulous space is maintained by a pontic that is engaged in the finishing orthodontic archwire (Fig 5, A and B) or in the lingual fixed retainer (Fig 5, C and D). A removable type of retainer with a pontic can also be used (Fig 5, E and F).

There are 3 methods for making a single temporary crown on top of the C-implant body (Fig 6). The first method uses a small extension wire through the hole of the head component and allows direct composite buildup (Fig 6, A-C). The C-implant head component

Fig 2. C-implant placement procedure for anterior maxilla (closed method): A and B, tissue punch for soft-tissue removal; C, guide drilling with straight handpiece; D-F, screw part placement.

Fig 3. C-implant placement procedure for anterior mandible (closed method).
is a titanium alloy that is difficult to cast. In addition, the head part is an ideal round shape with minimal retention. Therefore, an 0.8-mm wire is often placed in the hole of the head part to create a retentive arm in the resin buildup in the direct method. This approach is straightforward and has benefits of easy resin add-on or shave-off options as the edentulous space size changes in a growing patient.

The second method is to prepare the head part of the C-implant intraorally with burs into an ideal abutment shape and to treat this prepared head part with gold plating (Fig 6, D–F). Again, the size of the head part is determined based on the gingival depth at the alveolar crest and on the depth of the mini-implant body placement into the bone. Although the titanium-alloy material of the mini-implant head part is difficult to cast and does not permit porcelain buildup, the gold plating does allow porcelain buildup for a temporary crown. This technique uses an indirect method of telescopic abutment casting and porcelain buildup that adds a few more steps of procedure, but the resultant dental restoration is more durable with better esthetics. In addition, its high resistance to staining and fracture even enables this temporary crown to function as a final dental restoration if necessary.

The third method is similar to that of the standard restorative dental implant crown fabrication with an impression coping and a full-cast abutment (Fig 6, G–I). In general, the 1-mm long head part of the mini-implant is used as an impression coping for orthodontic temporary crown fabrication. A pickup impression is taken after attaching a small piece of 0.8-mm diameter wire to the hole of the 1-mm long head part for better retention. After the wax up and casting of the full gold abutment, a precisely fitting clinical crown restoration is built on top of it. The cast gold abutment is placed into the mini-implant body (friction retention), and then the crown is cemented to the cast abutment.

**CLINICAL APPLICATIONS**

A 23-year-old woman came to our office with primary concerns of excessive spacing distal to the mandibular right canine and tilted mandibular central incisors (Fig 7). Her general dental and skeletal patterns were in a solid Class I occlusion. However, her overjet and overbite were compromised because of the missing mandibular lateral incisor. Therefore, the treatment goal was to restore the missing tooth rather than closing the space and risk further compensation of the overjet and overbite. Treatment objectives included reestablishing the original space of the mandibular right lateral incisor by distalizing the adjacent canine and uprighting the mandibular central and lateral incisors while minimizing the involvement of the posterior dentition.

After completing approximately 4 months of orthodontic treatment, the patient agreed to have the space
restored with the orthodontic mini-implant cast-crown restoration method, since the size of the regained space was insufficient for placement of a conventional dental implant. In addition, the cost of orthodontic mini-implant cast-crown restoration is significantly lower than the minitype dental implants used by many periodontists because the orthodontic mini-implant system does not require additional system-specific surgical kits, which increase the base fee of any dental implant restoration.

After a mini-implant body (length, 10.5 mm; diameter, 1.8 mm) was placed at the regained space, an impression was taken by using a 1-mm long mini-implant head as an impression coping to cast a gold abutment (Fig 8). A porcelain crown was built and cemented on the gold cast abutment (Fig 9). Another method that can be used for such a case as this is to place the 3-mm long head part of the mini-implant and directly build a composite clinical crown at chair side.

A 14-year-old boy visited our clinic with primary concerns of spacing resulting from loss of a maxillary right lateral incisor from an accident a month earlier and also mild crowding in the mandibular anterior dentition (Fig 10). He had fallen on the floor at school, and the maxillary right lateral incisor was completely avulsed. According to the family, the tooth was not salvageable after the accident, and no attempt was made to preserve the tooth at the time. The patient also had an overretained right deciduous central incisor without a successor permanent central incisor. The overretained deciduous tooth was the cause of the excessive crowding in the mandibular anterior region.

The intraoral examination showed edge-to-edge overjet and overbite with Class I molar and canine relationships. The alveolar crest in the space resulting from the missing maxillary right lateral incisor manifested severe buccal wall resorption. Additionally, the avulsion socket site was losing its peripheral mesiodistal width because of rapid shifting of the adjacent teeth into the injured space. A limited treatment goal was established based on the patient’s desire to maintain the alveolar crest form and level until a final dental restoration can be placed and to align the mandibular anterior dentition. Therefore, the treatment objectives included
Fig 6. A-C, Single temporary crown fabrication methods; D-F, direct composite buildup on a small extension wire through the hole of the head component; G-I, the ready-made head part of the C-implant with gold plating and porcelain buildup, full-cast gold abutment and porcelain buildup.

Fig 7. Case 1. Pretreatment intraoral photographs of the 23-year-old patient.
regaining space to replace the lost maxillary right lateral incisor with a dental restoration and to orthodontically close the residual space after extraction of the overretained mandibular right deciduous central incisor; this would improve the anterior overjet and overbite.

Considering the patient’s young age and anticipated growth potential, a final dental implant restoration for the missing maxillary right lateral incisor was not recommended until his general growth is complete. However, the injured maxillary alveolar bone area was already showing advanced buccal bone resorption and was expected to worsen if a conventional fixed or removable orthodontic retainer was used to maintain the space, since these appliances do not have bone-preserving properties. Therefore, an orthodontic mini-implant temporary restoration was recommended for this patient to satisfy his esthetic concerns and prevent further buccal alveolar bone resorption until his general growth is completed in the next several years. The parents were informed that the patient would need to have a final implant restoration upon completion of growth, since the vertical level of the alveolar crest of temporary mini-implant restoration is expected to be lower than adjacent teeth in several years.

Before starting orthodontic treatment, the patient was referred for comprehensive dental care including oral hygiene instructions and dental cleaning. After extraction of the overretained mandibular right deciduous central incisor, the maxillary and mandibular teeth were leveled and aligned by using 0.016-in and 0.016 × 0.022-in nickel-titanium wires in 0.022-in slot preadjusted fixed appliances. After 2 months of active orthodontic treatment, the body part (length, 10.5 mm; diameter, 1.8 mm) of the mini-implant was placed at the injured alveolar bone area of the avulsed maxillary right lateral incisor (Fig 11). The 3-mm long head part of the mini-implant assembly was attached to the body and kept in place for the next 6 months to ensure

Fig 8. Case 1. Same patient: A and B, C-implant placement in the missing mandibular right lateral incisor area; C, full-cast abutment cemented to the screw part.

Fig 9. Case 1. Posttreatment intraoral photographs.
gingival patency above the mini-implant body for the temporary crown buildup.

After active orthodontic treatment, the temporary crown buildup was formed on the mini-implant and relieved from occlusion to prevent overload of occlusal force (Figs 12 and 13). Figure 14 shows the posttreatment retention records 4 years after placement of the temporary crown buildup. The maxillary fixed retainer connecting the mini-implant temporary crown restoration and its adjacent teeth was placed at the patient’s 4-year posttreatment retention follow-up visit so that the 3-dimensional growth of the maxillary alveolar bone would not be interrupted by the stationary mini-implant temporary crown restoration.

The comparison of the pretreatment and posttreatment periapical radiographic series of the area of the lost maxillary right lateral incisor shows normal healing of the alveolar bone around the mini-implant and adequate osseointegration between the mini-implant and the bone (Fig 15). No alveolar bone loss around the mini-implant was observed during the 4 years of retention.

DISCUSSION

There are 3 outstanding characteristics of the C-implant system that make it unique from any other orthodontic miniscrew system. First, the surface of the C-implant is SLA treated to induce higher levels of osseointegration of the mini-implant for better resistance to multidirectional orthodontic forces and torques.16-19 Second, the head part of this 2-piece mini-implant system can be easily exchanged with other sizes and shapes to accommodate differing orthodontic force levels, resulting in greater patient comfort during tooth movement.23,24 Third, this system minimizes excessive tension during the placement procedure by using a pilot drill hole.
followed by the self-tapping technique of the mini-implant body, in contrast with the self-drilling miniscrew technique.25,26

The advantages of using an orthodontic mini-implant temporary crown restoration as a space maintainer after orthodontic treatment include the following.

1. Orthodontic mini-implant placement systems are now becoming an integral routine clinical tool in most orthodontic practices. Therefore, the placement of a mini-implant to maintain edentulous space does not burden the clinician with additional overhead costs to purchase surgical kits for different sizes of implant bodies, thereby significantly reducing the fee of the procedure for the patient. In addition, the unit price of any orthodontic mini-implant is much lower than any restorative dental implant.

2. The technique of mini-implant placement for orthodontic anchors and space maintainers rarely involves open-flap periodontal surgery. Therefore, minimal additional training is required for orthodontists. An open-flap periodontal surgery might be indicated when the width between the buccal and lingual walls of alveolar bone is not clinically defined, such as in our second patient with the history of dental trauma.

3. The stability of the long-term use of the C-implant for orthodontic anchorage has proven to be excellent under multidirectional heavy forces.18,27 Although further investigation on the long-term stability of the orthodontic mini-implant temporary crown is needed, the clinical application of this C-implant mini-implant system as a temporary space maintainer appears to be promising as demonstrated in Figure 15, showing excellent stability after 4 years of posttreatment retention.

4. The 2-piece system of the orthodontic C-implant gives clinicians the freedom to choose the preferred method of temporary crown restoration fabrication (direct or indirect method).

5. The orthodontic mini-implant temporary crown can serve as a permanent dental restoration for a growing child if the mini-implant is well maintained throughout his or her growth period without significant changes of skeletal morphology that can affect the relative position of the orthodontic mini-implant temporary crown to adjacent teeth. Again, the 2-piece design of the C-implant makes the adjustment of the temporary crown

Fig 12. Case 2. Posttreatment intraoral photographs.

Fig 13. Case 2. Posttreatment panoramic radiograph of the same patient.
simple and easy when minor adjustments of the temporary crown might be necessary to accommodate natural skeletal growth during the child’s growth period.28

The 2-piece friction fit assembly system of the C-implant is an important property when it is used for orthodontic anchorage, since it gives orthodontists the option to select the preferred size of the head part as well as the direction of the archwire holes after the mini-implant body is fixed into the bone. However, increased retention at the joint of the 2-piece assembly might be more favorable when this system is used for mini-implant temporary crown restoration purposes.

At this time, therefore, efforts are being made to improve the 2-piece friction-fit assembly mechanism to secure retention of the temporary crown into the mini-implant body during various oral functions such as speech, mastication, and swallowing. Cementation of the temporary crown into the mini-implant body might be indicated if the orthodontic mini-implant temporary crown will be used as a permanent restoration when the patient’s general growth is complete. A lingual fixed retainer connecting the mini-implant temporary crown and the adjacent teeth can be another solution to increase the stability of the temporary crown. In addition, more variable designs of the head component need to be developed to further simplify the procedures necessary to fabricate a temporary crown after the mini-implant is placed in the edentulous area. Different head designs might open possibilities of more extensive applications of the orthodontic mini-implant, such as an implant coping under the overdenture of a patient for whom a standard restorative dental implant is.

Fig 14. Case 2. Four-year retention intraoral photographs.

Fig 15. Case 2. Periapical views: A, 1 month after the trauma; B, placement of the C-implant; C, adaptation of the prosthesis; D, year 3 of retention; E, year 4 of retention.
CONCLUSIONS

A 2-piece orthodontic mini-implant system can serve as an excellent treatment option to retain edentulous space after active orthodontic treatment until the future permanent restoration can be made.

REFERENCES