

DENTAL TECHNIQUE

Digital workflow to provide an immediate interim restoration after single-implant placement by using a surgical guide and a matrix-positioning device



Kyung Chul Oh, DDS, PhD,^a Changjoo Jeon, DDS,^b Ji-Man Park, DDS, MSD, PhD,^c and June-Sung Shim, DDS, PhD^d

Advances in the designs and surface characteristics of dental implants have led to radical changes in the guidelines for implant treatment.¹ Together with a conventional loading protocol, providing an immediate interim restoration with or without functional loading after an implant surgery has been suggested as a valid and predictable treatment option, showing favorable clinical outcomes with minimal peri-implant bone loss and stable soft tissue.²⁻¹²

An immediate interim restoration or nonfunctional immediate loading refers to a restoration free of all contacts, both in centric occlusion and during eccentric movements, which is inserted within 48 hours of implant surgery.^{13,14} It is differentiated from immediate loading or immediate functional loading, in which the interim restoration receives occlusal function within 48 hours of implant surgery.^{13,14}

Placing an interim restoration immediately after single-implant placement provides patients with esthetic, functional, and psychological benefits.¹⁵⁻¹⁸ Direct application of acrylic resin to a prefabricated abutment in the oral cavity after implant surgery has been one method of making immediate interim restorations.¹⁹ Other methods have used impression copings with polyether or polyvinyl siloxane impression materials to provide interim restorations immediately.^{5,20,21}

ABSTRACT

This article describes a workflow based on a top-down approach to provide a fixed-type immediate interim restoration after placing a single implant using a digitally driven surgical guide and a matrix-positioning device. A characteristic of the technique is that both the surgical guide and the matrix-positioning device are fabricated from a single diagnostic virtual trial restoration designed on computer-aided design (CAD) software. This workflow may shorten the time required for chairside placement of an interim restoration and enhance esthetics when rehabilitating anterior teeth. (J Prosthet Dent 2019;121:17-21)

The development of digital technologies for implant treatment has enabled a prosthetically driven top-down approach.²² A diagnostic trial restoration is necessary to achieve this goal.²³ First, the shape and position of the definitive restoration are predicted by digital diagnostic trial restoration in computer-aided design (CAD) software. Then, the diameter, length, and 3-dimensional (3D) position of the implant are determined after superimposing cone beam computed tomography (CBCT) data with digital trial restoration data in implant planning software. A surgical guide is designed and fabricated by using the implant planning software to place the implant in the preplanned position. Meanwhile, interim restorations can also be fabricated with the aid of CAD software.

The purpose of this article was to introduce a digital workflow that enables an immediate interim restoration to be made after single-implant placement by using a matrix-positioning device and a surgical guide, which

K.C.O. and C.J. contributed equally to this work.

^aClinical Research Assistant Professor, Department of Prosthodontics, College of Dentistry, Yonsei University, Seoul, Republic of Korea.

^bGraduate student, Department of Prosthodontics, College of Dentistry, Yonsei University, Seoul, Republic of Korea.

^cClinical Associate Professor, Department of Prosthodontics, College of Dentistry, Yonsei University, Seoul, Republic of Korea.

^dProfessor, Department of Prosthodontics, College of Dentistry, Yonsei University, Seoul, Republic of Korea.

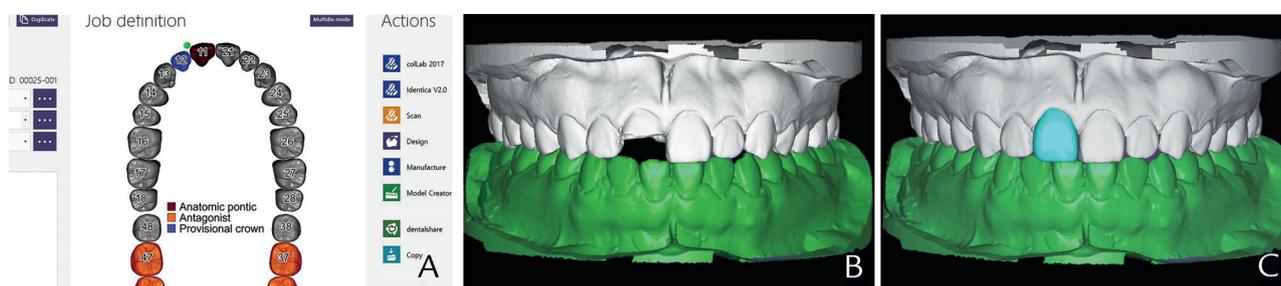


Figure 1. Designing digital diagnostic trial restoration with CAD software. A, Screenshot of applied modules. B, Scan data of maxillary and mandibular diagnostic casts. C, Diagnostic virtual trial restoration at site of future implant placement. CAD, computer-aided design.

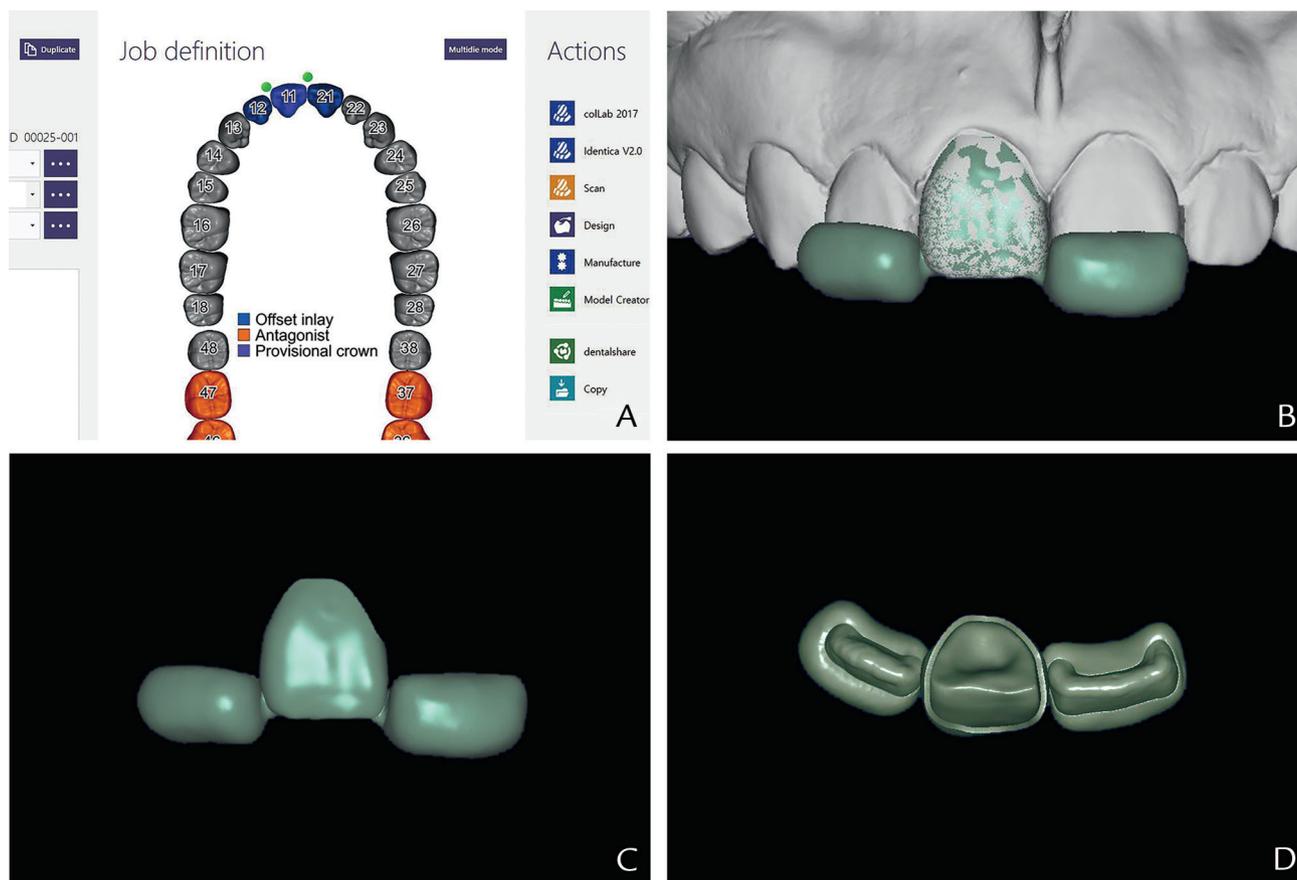


Figure 2. Designing matrix-positioning device with CAD software. A, Screenshot of applied modules. B, Design of matrix-positioning device based on diagnostic virtual trial restoration. Wings extended bilaterally to adjacent teeth to provide vertical stop. C, Labial view. D, Intaglio view. CAD, computer-aided design.

were fabricated based on a single diagnostic virtual trial restoration. To the authors' knowledge, this is the first article to suggest a digital workflow starting from a single diagnostic trial restoration to a surgical guide and an immediate interim restoration.

TECHNIQUE

1. Scan the maxillary and mandibular diagnostic casts using a tabletop scanner (Identica Blue; Medit Co) and design a diagnostic virtual trial restoration at

the site of future implant placement by using an anatomic pontic module in CAD software (exocad DentalCAD; exocad GmbH) (Fig. 1). Save the digitally modified diagnostic cast in standard tessellation language (STL) file format.

2. Load the STL file of the modified diagnostic cast of step 1 and design a matrix with bilateral wings in the same CAD software. Apply an interim crown module at the site of future implant placement for the matrix design to replicate the contours of the diagnostic virtual trial restoration of step 1. Apply offset inlay



Figure 3. Treatment planning based on top-down approach for implant placement. A, Superimposing STL files of virtual trial restoration and initial diagnostic cast with CBCT data. B, Cross-sectional view of CBCT at site of future implant placement. C, Design of surgical guide. STL, standard tessellation language. CBCT, cone beam computed tomography.

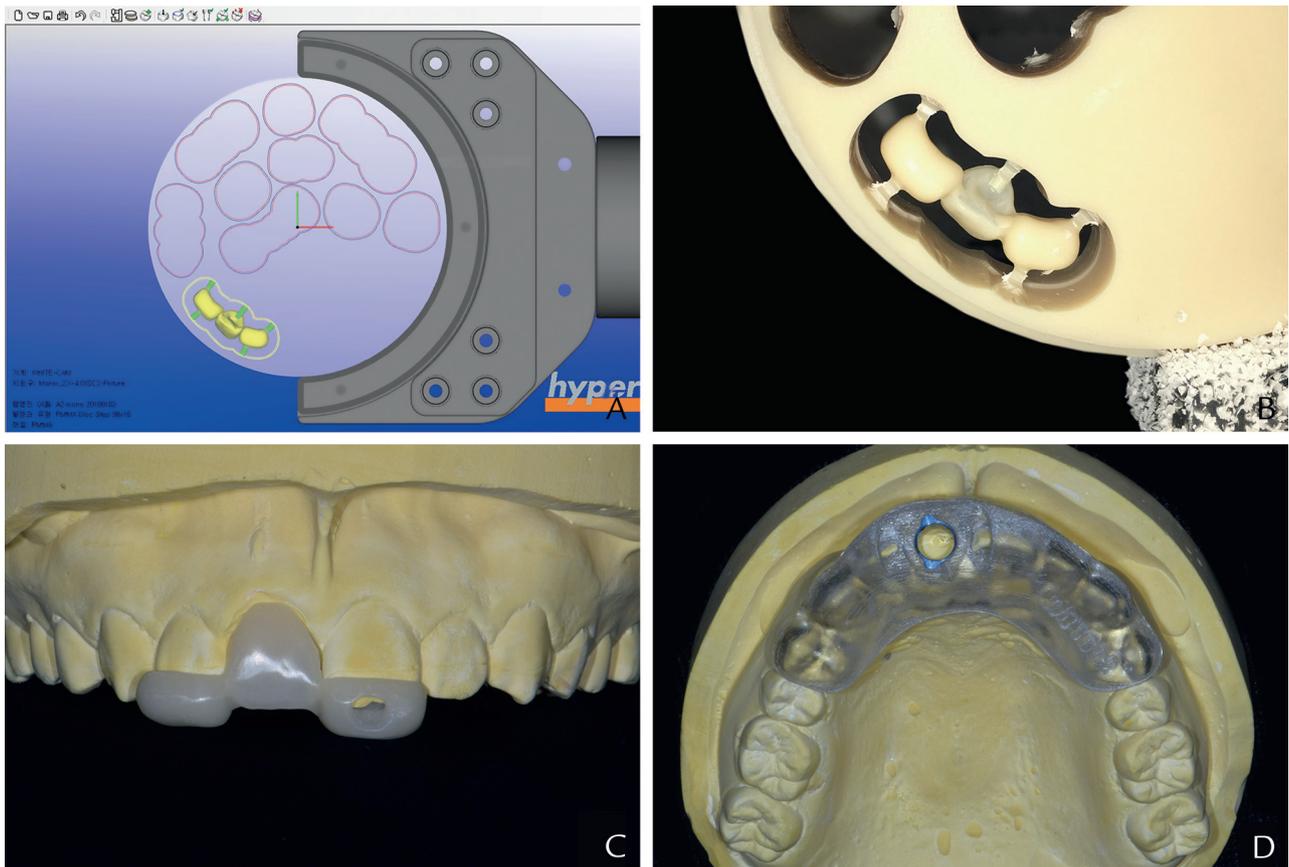


Figure 4. Output from CAD software. A, Screenshot of software of milling machine. B, Immediate output after milling matrix-positioning device with poly(methylmethacrylate) resin block. C, Matrix-positioning device. D, Surgical guide. CAD, computer-aided design.

modules at adjacent teeth for the wing design that extends from the matrix and covers one-third of the adjacent teeth, to provide a vertical stop. This complex refers to a matrix-positioning device (Fig. 2).

3. Import the STL files of the virtual trial restoration and the initial diagnostic cast of step 1 into an implant planning CAD software (OnDemand3D; Cybermed Inc) and superimpose the files with the CBCT data. Establish a treatment plan for implant placement and design a surgical guide based on the treatment plan by using the same CAD software (Fig. 3).

4. Fabricate the matrix-positioning device with a poly (methylmethacrylate) resin block (VIPI Block Trilux; VIPI Ltd) by using a milling machine (White CAM; Megagen) and the surgical guide (In2Guide; Cybermed Inc) with a PolyJet photopolymer (MED610; Stratasys) by using a 3D printer (Objet Eden260V; Stratasys) (Fig. 4). Evaluate their adaptation on the diagnostic cast. In the case of immediate implantation, in which extraction precedes implant surgery, the diagnostic cast needs to be modified.

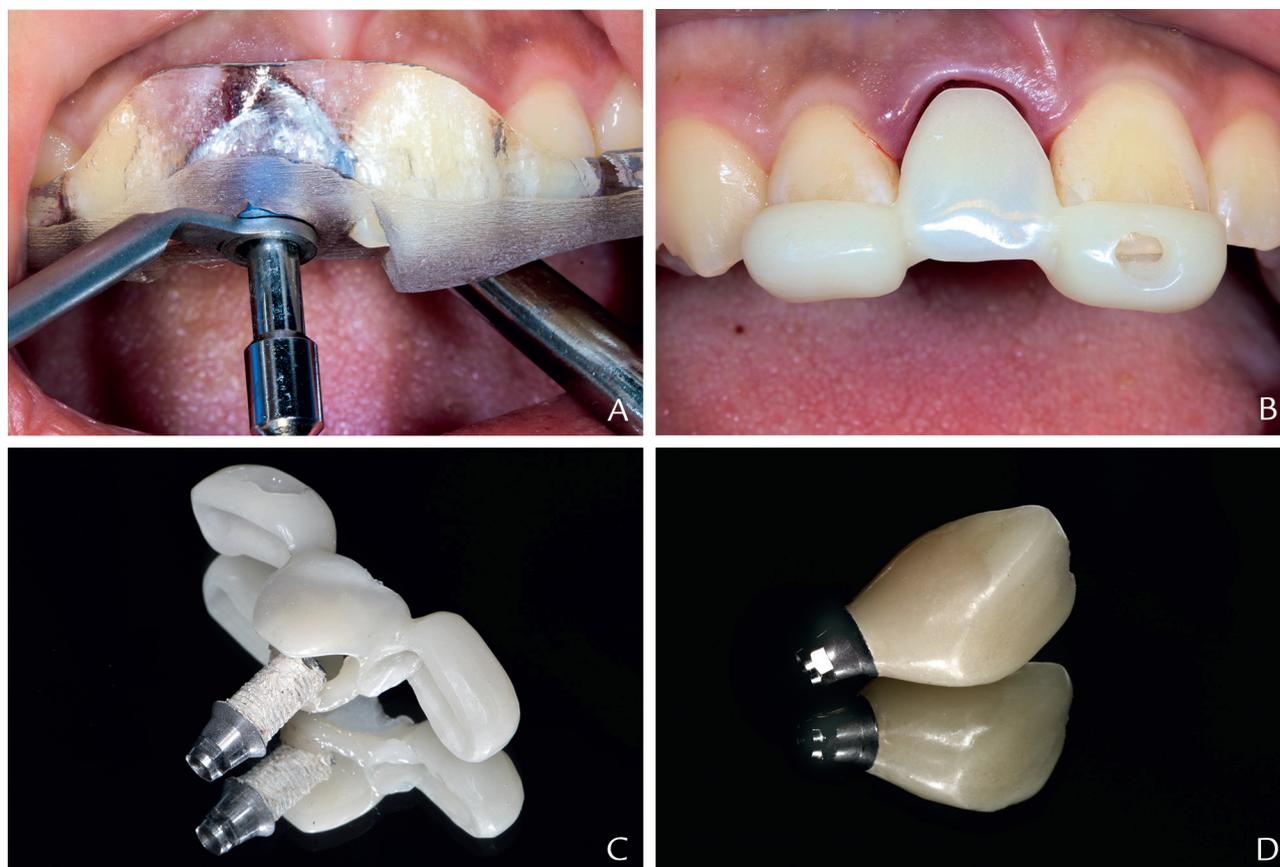


Figure 5. Clinical procedures. A, Implant placement by using surgical guide. B, Clinical evaluation of matrix-positioning device after connecting interim dental implant abutment with implant fixture. C, Spot attachment of matrix-positioning device to interim dental implant abutment with composite resin. D, Finalized immediate interim restoration.

5. Place the implant by using the surgical guide and connect an interim dental implant abutment (Ti-Temporary Abutment; Dentium) to the implant. The interim dental implant abutment should be coated with an opaquer (Sinfony; 3M ESPE). Place the matrix-positioning device and spot attach the interim dental implant abutment to the device with composite resin (Z100; 3M ESPE) to unite them as a single unit. Remove the complex from the oral cavity, build up the unfilled areas with composite resin, and trim the wings from the device to finalize the immediate interim restoration (Fig. 5).
6. Place the immediate interim restoration after the implant surgery (Fig. 6).

DISCUSSION

The workflow presented was based on a single digital diagnostic trial restoration (Fig. 7). It reproduced the predetermined form of the digital diagnostic trial restoration for the immediate interim restoration. To achieve this goal, the diagnostic virtual trial restoration was incorporated into the implant planning CAD software to determine the type and 3D position of the implant. The



Figure 6. Placement of immediate interim restoration after implant surgery.

trial restoration was also modified into a matrix with bilateral wings to function as a device to guide the position of the immediate interim restoration.

The technique is especially beneficial in the planning of an immediate interim restoration after implant placement in the anterior region, regardless of whether the implant is placed after extraction (immediate implantation) or in an

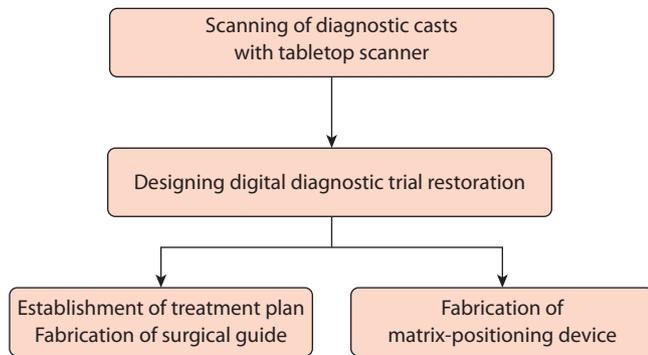


Figure 7. Digital workflow to provide immediate interim restoration after single-implant placement based on single diagnostic virtual trial restoration.

edentulous area. It eliminates the need for a removable prosthesis, reduces the length of the edentulous stage, and minimizes material-handling time inside the oral cavity. It may also reduce the overall treatment time and increase patient acceptance.¹⁵ It does not cause discomfort and is free from potential contamination that could be caused by direct contact of the impression material with the surgical fields.²¹ Composite resin was used to finalize the interim restoration because of its ease of handling and polishing, which may reduce surgical exposure time and facilitate oral hygiene. The technique can be used for immediate loading either by creating occlusal contacts during designing procedures in CAD software or by chairside build up of the lingual surface of the immediate interim restoration.

The diagnostic virtual trial restoration should be thoroughly evaluated for the success of the presented technique because the overall workflow is based on this trial restoration. If the CBCT data are carelessly superimposed with the STL file of the virtual trial restoration or if the adaptation of the surgical guide is poor, the implant cannot be placed at the predetermined position. Thus, the matrix-positioning device will be of no use or require many modifications to its contour.

SUMMARY

The digital workflow described facilitates the fabrication of an immediate interim restoration. A digital diagnostic trial restoration serves as the basis for determining the path and location of the implant and for fabricating the matrix-positioning device. This technique may especially benefit patients receiving immediate implantation or an implant placement of a single missing tooth in the esthetic zone because the presence of a customized matrix improves esthetics and reduces the time required for chairside completion of an interim restoration.

REFERENCES

1. Barone A, Rispoli L, Voza I, Quaranta A, Covani U. Immediate restoration of single implants placed immediately after tooth extraction. *J Periodontol* 2006;77:1914-20.

2. Wohrle PS. Single-tooth replacement in the aesthetic zone with immediate provisionalization: fourteen consecutive case reports. *Pract Periodontics Aesthet Dent* 1998;10:1107-14; quiz 16.
3. Kan JY, Rungcharassaeng K. Immediate placement and provisionalization of maxillary anterior single implants: a surgical and prosthodontic rationale. *Pract Periodontics Aesthet Dent* 2000;12:817-24; quiz 26.
4. Degidi M, Piattelli A. Immediate functional and non-functional loading of dental implants: a 2- to 60-month follow-up study of 646 titanium implants. *J Periodontol* 2003;74:225-41.
5. Lindeboom JA, Frenken JW, Dubois L, Frank M, Abbink I, Kroon FH. Immediate loading versus immediate provisionalization of maxillary single-tooth replacements: a prospective randomized study with BioComp implants. *J Oral Maxillofac Surg* 2006;64:936-42.
6. De Rouck T, Collys K, Wyn I, Cosyn J. Instant provisionalization of immediate single-tooth implants is essential to optimize esthetic treatment outcome. *Clin Oral Implants Res* 2009;20:566-70.
7. Degidi M, Nardi D, Piattelli A. Immediate versus one-stage restoration of small-diameter implants for a single missing maxillary lateral incisor: a 3-year randomized clinical trial. *J Periodontol* 2009;80:1393-8.
8. Donati M, La Scala V, Di Raimondo R, Speroni S, Testi M, Berglundh T. Marginal bone preservation in single-tooth replacement: a 5-year prospective multicenter study. *Clin Implant Dent Relat Res* 2015;17:425-34.
9. Cosyn J, Eghbali A, Hermans A, Vervaeke S, De Bruyn H, Cleymaet R. A 5-year prospective study on single immediate implants in the aesthetic zone. *J Clin Periodontol* 2016;43:702-9.
10. Saito H, Chu SJ, Reynolds MA, Tarnow DP. Provisional restorations used in immediate implant placement provide a platform to promote peri-implant soft tissue healing: a pilot study. *Int J Periodontics Restorative Dent* 2016;36:47-52.
11. Van Nimwegen WG, Goene RJ, Van Daelen AC, Stellingsma K, Raghoebar GM, Meijer HJ. Immediate implant placement and provisionalization in the aesthetic zone. *J Oral Rehabil* 2016;43:745-52.
12. Arora H, Khzam N, Roberts D, Bruce WL, Ivanovski S. Immediate implant placement and restoration in the anterior maxilla: tissue dimensional changes after 2-5 year follow up. *Clin Implant Dent Relat Res* 2017;19:694-702.
13. Cochran DL, Morton D, Weber HP. Consensus statements and recommended clinical procedures regarding loading protocols for endosseous dental implants. *Int J Oral Maxillofac Implants* 2004;19 Suppl:109-13.
14. Morton D, Jaffin R, Weber HP. Immediate restoration and loading of dental implants: clinical considerations and protocols. *Int J Oral Maxillofac Implants* 2004;19 Suppl:103-8.
15. Chung S, McCullagh A, Irinakis T. Immediate loading in the maxillary arch: evidence-based guidelines to improve success rates: a review. *J Oral Implantol* 2011;37:610-21.
16. Avila G, Galindo P, Rios H, Wang HL. Immediate implant loading: current status from available literature. *Implant Dent* 2007;16:235-45.
17. Degidi M, Piattelli A, Gehrke P, Felice P, Carinci F. Five-year outcome of 111 immediate nonfunctional single restorations. *J Oral Implantol* 2006;32:277-85.
18. Misch CE, Wang HL, Misch CM, Sharawy M, Lemons J, Judy KW. Rationale for the application of immediate load in implant dentistry: part II. *Implant Dent* 2004;13:310-21.
19. Cooper LF, Raes F, Reside GJ, Garriga JS, Tarrida LG, Wiltfang J, et al. Comparison of radiographic and clinical outcomes following immediate provisionalization of single-tooth dental implants placed in healed alveolar ridges and extraction sockets. *Int J Oral Maxillofac Implants* 2010;25:1222-32.
20. Testori T, Galli F, Capelli M, Zuffetti F, Esposito M. Immediate nonocclusal versus early loading of dental implants in partially edentulous patients: 1-year results from a multicenter, randomized controlled clinical trial. *Int J Oral Maxillofac Implants* 2007;22:815-22.
21. Schincaglia GP, Marzola R, Giovanni GF, Chiara CS, Scotti R. Replacement of mandibular molars with single-unit restorations supported by wide-body implants: immediate versus delayed loading. A randomized controlled study. *Int J Oral Maxillofac Implants* 2008;23:474-80.
22. Stapleton BM, Lin WS, Ntounis A, Harris BT, Morton D. Application of digital diagnostic impression, virtual planning, and computer-guided implant surgery for a CAD/CAM-fabricated, implant-supported fixed dental prosthesis: a clinical report. *J Prosthet Dent* 2014;112:402-8.
23. Viana PC, Correia A, Neves M, Kovacs Z, Neugbauer R. Soft tissue waxup and mock-up as key factors in a treatment plan: case presentation. *Eur J Esthet Dent* 2012;7:310-23.

Corresponding author:

Dr June-Sung Shim
College of Dentistry, Yonsei University
50-1 Yonsei-ro, Seodaemun-gu
Seoul 03722
REPUBLIC OF KOREA
Email: jfshim@yuhs.ac

Copyright © 2018 by the Editorial Council for *The Journal of Prosthetic Dentistry*.
<https://doi.org/10.1016/j.prosdent.2018.03.029>