

ORIGINAL ARTICLE

Three-point sectional-cast digital method for transferring the interocclusal relationship for full-mouth rehabilitation of worn dentition

Xiaoqiang Liu DDS, PhD¹  | Ti Zhou DDS² | Hanqi Gao DDS, PhD³  |
 Jianfeng Zhou DDS, PhD¹ | Deli Li DDS, PhD¹ | Jianguo Tan DDS, PhD¹ 

¹Department of Prosthodontics, Peking University School and Hospital of Stomatology & National Center of Stomatology & National Clinical Research Center for Oral Diseases & National Engineering Research Center of Oral Biomaterials and Digital Medical Devices, Beijing, P. R. China

²Fushan Branch, Yantai Stomatology Hospital, Yantai, P. R. China

³Department of Second Dental Center, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, College of Stomatology, Shanghai Jiao Tong University; National Center for Stomatology; National Clinical Research Center for Oral Diseases; Shanghai Key Laboratory of Stomatology, Shanghai, P. R. China

Correspondence

Jianguo Tan, Department of Prosthodontics, Peking University School and Hospital of Stomatology, No. 22, Zhongguancun Avenue South, Haidian District, Beijing 100081, P. R. China.
 Email: kqtanjg@icloud.com

Funding information

China University Industry-University-Research Innovation Fund, Grant/Award Number: 2021ITA05007; Peking University School and Hospital of Stomatology, Grant/Award Number: PKUSSNCT-21B01

Abstract

For full-mouth rehabilitation of worn dentition, “diagnostic” interim restorations are required to reestablish the interocclusal relationship. It is important but challenging to transfer the interocclusal relationship and to map the basic form and contour of interim restorations to the final restorations. Alignment of interim restorations and working casts is difficult when using digital workflows because of a lack of consistent hard tissue reference points. The digital workflow presented in this study used a “3-point sectional-cast digital cross-mounting method” to transfer the interocclusal relationship during full-mouth rehabilitation. An intermediate cast was made with three interim restorations: one on an incisor and two on molars. The interocclusal relationship and occlusal morphologies of the diagnostic interim prostheses were transferred and aligned to working casts using the 3-point sectional casts.

KEYWORDS

dental articulators, dental occlusion, digital technology, mouth rehabilitation

Rehabilitation of worn dentition is a complex operation that involves reconstruction of dental morphology and interocclusal relationships based on functional occlusion at the individual level.¹ Interim restorations are used for a few months to allow jaw adaptation in terms of position and movement. Final restorations are then fabricated based on the interim restorations.^{2,3} Interim restorations can reestablish the occlusal vertical dimension (OVD) and centric relation. Eccentric movement can be recorded on the occlusal surfaces of interim restorations because the interim resin material has

low hardness and is subjected to wear. The occlusal morphologies of the interim restorations after a period of use are replicated in the final prostheses to ensure accurate transfer of the OVD, as well as centric and eccentric occlusion.

The interocclusal relationship is generally transferred from interim to final restorations by cross-mounting on articulators, which is a complicated and time-consuming process requiring a skilled operator.⁴⁻⁶ Digital workflows are widely used for registering natural teeth or provisional restorations on working casts^{7,8} and for replicating planned morphologies in final restorations for partial arch restoration. However, digital workflows are difficult to use in cases of full-mouth

Xiaoqiang Liu and Ti Zhou contributed equally to this work and share the first author merit.

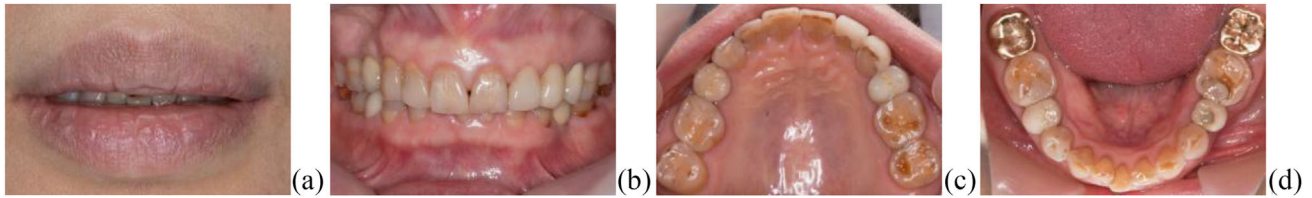


FIGURE 1 Clinical findings at presentation. (a) Extraoral view at rest. (b) Intraoral view of the intercuspal position. (c) Maxillary occlusal view. (d) Mandibular occlusal view



FIGURE 2 Clinical view of the “diagnostic” interim restorations. (a) Extraoral view at rest. (b) Extraoral view of the smile. (c) Intraoral view of the intercuspal position

rehabilitation, which involve the preparation of all abutment teeth and lack consistent hard tissue reference points between provisional restorations and working casts.⁹ Soft tissue areas of interim restoration and working casts have been used for registration,¹⁰ but they lack features that could guide intraoral scanning; this leads to splicing errors. Additionally, soft tissues may be deformed during traditional impressions, resulting in errors during registration.¹¹

The present technique describes a digital workflow using a “3-point sectional-cast digital cross-mounting method” for full-mouth rehabilitation cases. Intermediate casts were made, and three interim restorations were placed: one on an incisor and two on bilateral molars. The remaining teeth were also prepared for registration. Registration of provisional prostheses using the 3-point segmental and working casts allowed unification of their coordinate systems. The morphologies and occlusal forms of interim restorations could then be transferred to the final prostheses, to ensure accurate esthetic and functional replication.

TECHNIQUE

A digital workflow was applied in the treatment of a 52-year-old female patient with severely worn dentition. The patient complained of short teeth, masticatory weakness, an aged appearance, and a lack of tooth display when smiling. She had no discomfort in the temporomandibular joints or masticatory muscles. The following procedures can be used to carry out the present method.

1. Perform clinical examination and acquire diagnostic imaging. In this case, the clinical examination revealed that no maxillary central incisors were exposed at rest (Figure 1a). The occlusion was stable (Figure 1b) and the dentition was worn down to the dentin layer (Figure 1c,d).
2. Fabricate the diagnostic interim restoration. After thorough esthetic analysis, facebow record, and occlusal design, provide the patient with an occlusal splint at the appropriate OVD, followed by mock-up and diagnostic interim restorations (Luxatemp Star; DMG Chemisch-Pharmazeutische Fabrik GmbH, Hamburg, Germany). The resting maxillary central incisor exposure was 2 mm, and the occlusal relationship was stable and coordinated (Figure 2).
3. Fabricate three groups of digital maxillary and mandibular casts. The first group was the interim restoration dentition when all interim restorations were in place with a stable interocclusal relationship (Figure 3a,b). The second group was the 3-point segmental casts of the mixed dentition consisting of tooth preparations and three sets (one on an incisor and two on bilateral molars) of interim restorations (Figure 3c,d). The third group was complete-arch tooth preparations without interim restorations (Figure 3e,f). Make analog impressions (Impregum; 3M ESPE AG, Seefeld, Germany) first and scan them to achieve digital casts using a laboratory scanner (D2000; 3Shape, Copenhagen, Denmark).
4. Transfer the interocclusal relationship. Save the digital cast data in standard tessellation language format and transfer them into 3D reverse engineering software (Geomagic Studio 2014; 3D Systems, Rock Hill, SC, USA) for registration. Align the interim restoration casts with the 3-point segmental casts based on the three common areas (Figure 4), and align the working cast with the 3-point segmental cast in a similar manner (Figure 5). Register the interocclusal relationship of the interim restoration casts to the maxillary and mandibular working casts (Figure 6).
5. Design and manufacture the final restorations. Copy the interim restoration morphologies to the final restorations

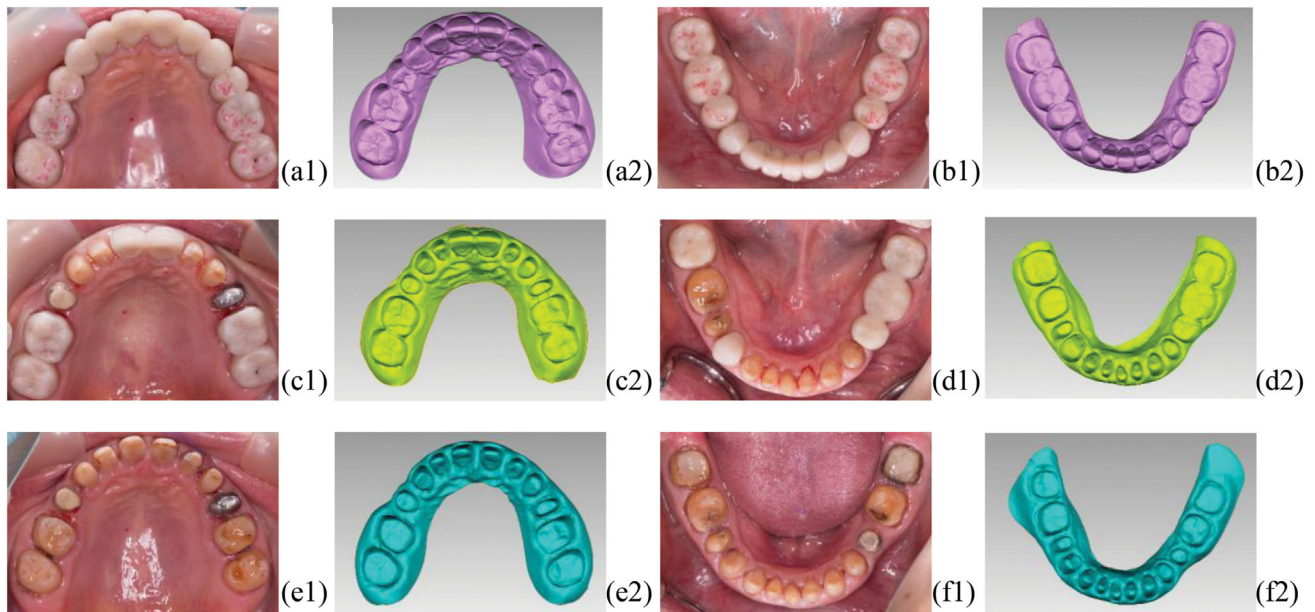


FIGURE 3 Intraoral photos and digital casts of the provisional restoration, 3-point segmental dentition, and prepared teeth. (a) Maxillary interim restoration. (b) Mandibular interim restoration. (c) Maxillary 3-point segmental dentition. (d) Mandibular 3-point segmental dentition. (e) Maxillary prepared teeth. (f) Mandibular prepared teeth. (1) Intraoral photos. (2) Digital casts used for registration

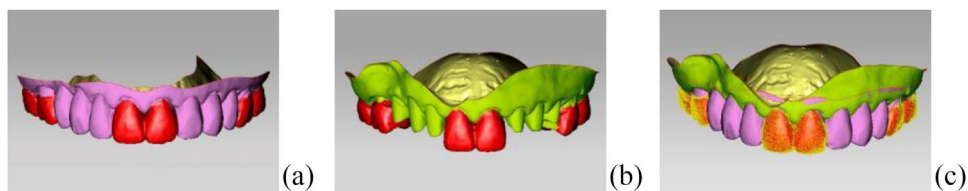


FIGURE 4 Registration of the maxillary interim restoration and 3-point segmental casts. (a) Common areas on the interim restoration cast. (b) Common areas on the 3-point segmental cast. (c) Images from (a) and (b) were superimposed to complete the registration

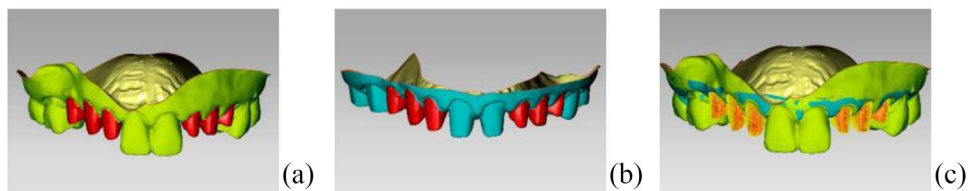


FIGURE 5 Registration of the maxillary working and 3-point segmental casts. (a) Common areas on the 3-point segmental cast. (b) Common areas on the working cast. (c) Images from (a) and (b) were superimposed to complete the registration

in a computer-aided design and computer-aided manufacturing (CAD–CAM) system (exocad; exocad GmbH, Darmstadt, Germany) (Figure 7), followed by labial surface reduction of the four maxillary incisors. Mill monolithic disilicate glass-ceramic CAD–CAM crowns (LTVA1; Upcera, Shenzhen, China) and add feldspathic porcelain to the labial surfaces of the maxillary incisors.

6. Prepare the final restoration. Finish the final restorations after try-in and minor occlusal adjustments, and cement them using resin cement (PANAVIA V5; Kuraray Co., Ltd., Tokyo, Japan). In this case, satisfactory esthetic

appearance with 2-mm increased max anterior tooth display, stable occlusion, and appropriate occlusal morphology were seen at the 3-month follow-up (Figure 8).

DISCUSSION

In cases of full-mouth rehabilitation, it may be necessary to modify interim restorations several times to achieve satisfactory occlusal and esthetic outcomes.¹² Interim restorations establish centric occlusion and the OVD. Accurate transfer

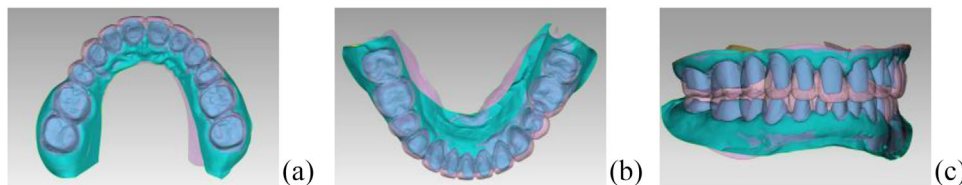


FIGURE 6 Registration of the working casts to the interim restorations cast. (a) Maxillary dentition. (b) Mandibular dentition. (c) Maxillary and mandibular dentition with interocclusal relationship

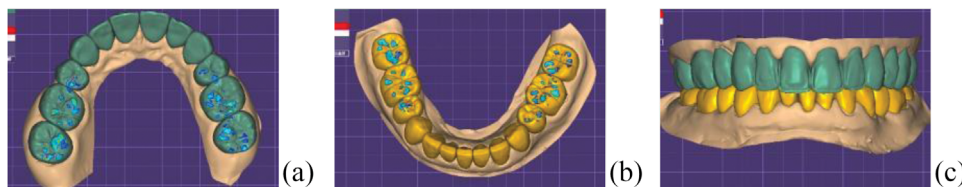


FIGURE 7 Transfer of morphologies and the occlusal relationship of interim restorations to the final restorations. (a) Maxillary restorations. (b) Mandibular restorations. (c) Labial surface reduction of the four maxillary incisors

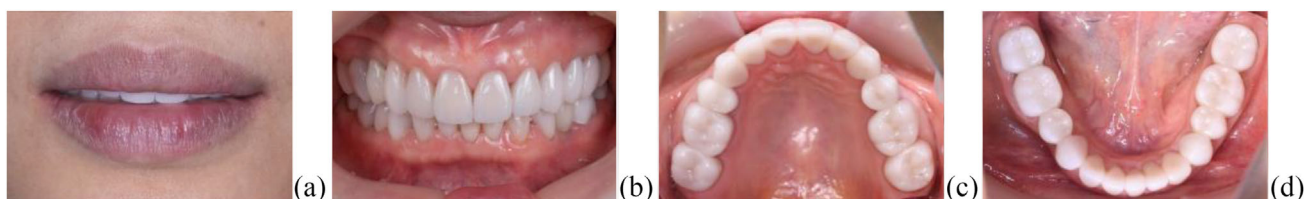


FIGURE 8 Clinical findings at the 3-month follow-up. (a) Extraoral view at rest. (b) Intraoral view in the intercuspal position. (c) Maxillary occlusal view. (d) Mandibular occlusal view

of the interim interocclusal relationship and tooth morphologies to the final restorations is the key to successful full-mouth rehabilitation. The present 3-point sectional-cast digital method introduced a new approach for cast registration in full-mouth rehabilitation.

Accurate digital impressions are important for a successful outcome. Digital impressions include direct and indirect scans, also known as intraoral and extraoral scans, respectively. Direct scanning is performed intraorally to obtain digital models of soft and hard tissues,¹³ whereas indirect scanning is performed for traditional impressions or plaster models using laboratory scanners.¹⁴ Advances in scanners and impression materials have increased the use of indirect impression scanning,¹⁵ which obviates the need for plaster model pouring and thus saves time.¹⁶ We previously compared the accuracy of digital impressions based on intraoral, impression, and cast scanning and demonstrated that the accuracy was highest with impression scans. Therefore, in the present study, high-precision digital impressions were recorded using a laboratory scanner.

Accurate transfer of the interocclusal relationship of diagnostic interim restorations is crucial but challenging. In analog workflows, interim restorations are usually partially jaw-retained to support the occlusal relationship. However,

the occlusion and mandibular positions may change due to partial loss of support, which may lead to discrepancies between the interim and final restorations. Previous studies reported digital methods to determine the interocclusal relationship by scanning invariant soft or hard tissues of both arches.^{7,8} With the present method, tooth morphologies and the interocclusal relationship are recorded with all interim restorations in place; therefore, the interocclusal relationship remains stable. Multiple occlusal records are not required during the preparation of 3-point segmental and working casts, which saves time. Furthermore, the interim restorations for 3-point segmental casts are distributed in a triangle shape and are separated by the greatest distances possible to prevent rotation errors. As the occlusal morphologies were copied from interim restorations to final restorations in the same coordinate system, the interocclusal relationship would be transferred accordingly.

The success of the technique described herein depends on several factors. First, the interim restorations should be divided into sections during fabrication, to dissociate the “3-point restorations” from other sites and allow easy prosthesis removal during transfer. Second, convex features, such as cusps and point angles, are preferable for alignment because the depth of impression material penetration into grooves may vary; concave features such as pits, fossas, and grooves

should be avoided. Third, areas above the cervical margins of provisional restorations and marginal edges of preparations should guide registration.

In the present study, a 3-point sectional-cast digital cross-mounting method was used to transfer the morphologies and interocclusal relationship of the diagnostic interim restorations to the final restorations. This may improve dental efficiency and reduce the time required for occlusion adjustments. However, a degree of proficiency in the use of reverse engineering software is needed. Further research is required to evaluate the accuracy of our digital CAD workflow and minimize technical difficulties.

SUMMARY

This study used a digital workflow and a 3-point sectional-cast digital cross-mounting method to transfer the interocclusal relationship for full-mouth rehabilitation in a case of worn dentition. More comprehensive pros and cons should be confirmed through further clinical investigations.

ACKNOWLEDGMENTS

The authors thank the technician Xin Xu from Zhenzhi (Dalian) Medical Equipment Co., Ltd. for technical support.

CONFLICT OF INTEREST

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

ORCID

Xiaoqiang Liu DDS, PhD  <https://orcid.org/0000-0002-3427-2130>

Hanqi Gao DDS, PhD  <https://orcid.org/0000-0001-7161-0752>

Jianguo Tan DDS, PhD  <https://orcid.org/0000-0002-4312-9184>

REFERENCES

1. Song M-Y, Park J-M, Park E-J. Full mouth rehabilitation of the patient with severely worn dentition: a case report. *J Adv Prosthodont.* 2010;2:106–10 PMID: 21165279

2. Güth J-F, Almeida E Silva JS, Ramberger M, Beuer F, Edelhoff D. Treatment concept with CAD/CAM-fabricated high density polymer temporary restorations. *J Esthet Restor Dent.* 2012;24:310–8 PMID: 23025313
3. Saratti CM, Merheb C, Franchini L, Rocca GT, Krejci I. Full-mouth rehabilitation of a severe tooth wear case: a digital, esthetic and functional approach. *Int J Esthet Dent.* 2020;15:242–62 PMID: 32760922
4. Kordaß B, Gärtner C, Söhnel A, Bisler A, Voß G, Bockholt U, et al. The virtual articulator in dentistry: concept and development. *Dent Clin North Am.* 2002;46:493–506 PMID: 12222093
5. Lee W, Kwon H-B. Vertical repositioning accuracy of magnetic mounting systems on 4 articulator models. *J Prosthet Dent.* 2018;119:446–9 PMID: 28689914
6. Alghazzawi TF. Advancements in CAD/CAM technology: options for practical implementation. *J Prosthodont Res.* 2016;60:72–84 PMID: 26935333
7. Venezia P, Torsello F, D'Amato S, Cavalcanti R. Digital cross-mounting: a new opportunity in prosthetic dentistry. *Quintessence Int.* 2017;48:701–9 PMID: 28849806
8. Li J, Galli M, Chen Z, Venezia P, Mangano F, Lepidi L. A novel digital technique for maintaining maxillomandibular relations in fixed prosthetic rehabilitations. *J Dent.* 2021;114:103798 PMID: 34517071
9. Roberts M, Shull F, Schiner B. Maxillary full-arch reconstruction using a sequenced digital workflow. *J Esthet Restor Dent.* 2020;32:336–56 PMID: 32424888
10. Unkovskiy A, Unkovskiy N, Spintzyk S. A virtual patient concept for esthetic and functional rehabilitation in a fully digital workflow. *Int J Comput Dent.* 2021;24:405–17 PMID: 34931776
11. Renne WG, Evans ZP, Mennito A, Ludlow M. A novel technique for reference point generation to aid in intraoral scan alignment. *J Esthet Restor Dent.* 2017;29:391–5 PMID: 28653808
12. Vlaar ST, Van Der Zel JM. Accuracy of dental digitizers. *Int Dent J.* 2006;56:301–9 PMID: 17069074
13. Joda T, Bragger U, Gallucci G. Systematic literature review of digital three-dimensional superimposition techniques to create virtual dental patients. *Int J Oral Maxillofac Implants.* 2015;30:330–7 PMID: 25830393
14. Masri R, Driscoll CF. *Clinical applications of digital dental technology.* Ames, Iowa: John Wiley & Sons; 2015
15. Keul C, Runkel C, Güth J, Schubert O. Accuracy of data obtained from impression scans and cast scans using different impression materials. *Int J Comput Dent.* 2020;23:129–38 PMID: 32555766

How to cite this article: Liu X, Zhou T, Gao H, Zhou J, Li D, Tan J. Three-point sectional-cast digital method for transferring the interocclusal relationship for full-mouth rehabilitation of worn dentition. *J Prosthodont.* 2023;32:273–277.
<https://doi.org/10.1111/jopr.13636>