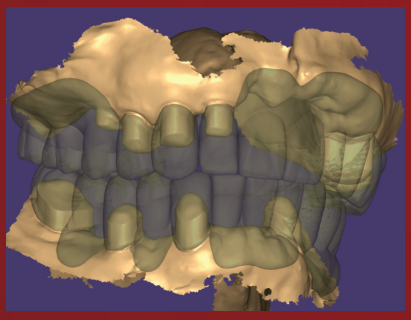
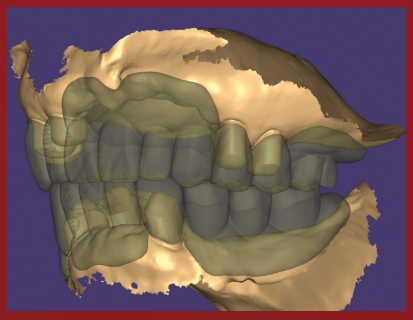
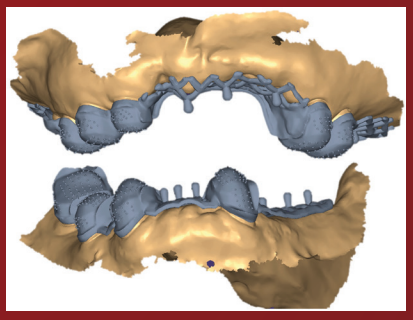
The Academy of Prosthetic Dentistry R.O.C., Taiwan

Journal of Prosthodontics and Implantology

Official Journal of
The Academy of Prosthetic Dentistry, R.O.C., Taiwan

Volume 13 Number 1
March 2024

Journal of Prosthodontics and Implantology

中華民國贋復牙科學會期刊

Vol.13, No.1 March 2024

***Publisher* / 發行人**

Tong-Mei Wang, DDS, MS, PhD

Associate Professor, School of Dentistry, National Taiwan University, Taipei, TaiwanField of interest: Biomechanics and Esthetics of Dental Implants,Maxillofacial Prosthetics, Rehabilitation ofHead and Neck Cancer Patients

***Editor-in-Chief* / 總編輯**

Li-Deh Lin, DDS, PhD

Professor and Dean, School of Dentistry, National Taiwan University, Taipei, Taiwan Director, Department ofDentistry, National Taiwan University Hospital, Taipei, Taiwan
Field of interest: Fixed and Removable Prosthodontics, Implant Prosthodontics, Occlusion, TMD

***Editorial Secretary* / 編輯秘書**

Kai-Ting Yu

***Honorary Editor-in-Chief* / 榮譽總編輯**

Yuh-Yuan Shiau, DDS,MS,MFICD

Professor Emeritus, School of Dentistry, National Taiwan University,
Chair Professor, School of Dentistry, China Medical University, Taichung, Taiwan
Field of interest: Fixed and Removable Prosthodontics, Occlusion, TMD

***Executive Editor* / 執行編輯**

Ting-Hsun Lan, DDS, MS, PhD

Associate Professor, School of Dentistry, College of Dental Medicine, Kaohsiung Medical University,Kaohsiung, Taiwan.
Head, Division of Prosthodontics, Department of Dentistry, Kaohsiung Medical University Hospital, Kaohsiung,Taiwan.

***Editorial Board* / 編輯委員**

Yen-Wen Shen, MS

Assistant Professor, School of Dentistry, China Medical University, Taichung, Taiwan
Field of interest: Fixed and Removable Prosthodontics, Implant Prosthodontics, Esthetic Dentistry,Maxillofacial Prosthodontics.

Chun-Cheng Hung, DDS, PhD

Professor, School of Dentistry, Kaohsiung Medical University, Kaohsiung, Taiwan, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan
Field of interest: Fixed Prosthodontics, Dental Materials, Occlusion

Yung-Chung Chen, DDS, MDsc, PhD

Associate Professor, School of Dentistry & Institute of Oral Medicine, College of Medicine, National Cheng KungUniversity, Tainan, Taiwan
Chief, Division of Prosthodontics, Department of Stomatology, National Cheng Kung University Hospital, Tainan, TaiwanField of interest: Fixed and removable prosthodontics, Prosthetic Design, Dental biomechanics

Wen-Cheng Chen, PhD

istinguished Professor, Department of Fiber and Composite Materials, Feng Chia University.Field of interest: Biomaterials, Composite, Fibers, Tissue Engineering, Functional ceramics, Membrane

Po-Sung Fu, DDS, MS, PhD

Attending Staff, Division of Clinical Dentistry, Department of Dentistry, Kaohsiung Medical University HospitalField of interest: Fixed Prosthodontics, Implant Prosthodontics

Min-Chieh Liu,

Department Head, Division of Restorative and Esthetic Dentistry, Shin-Kong Wu Ho-Su Memorial Hospital

Tsung-Chieh, Yang. DDS, PhD

Associate Professor
School of Dentistry,National Taiwan University
Field of interest: Fixed and Removable Prosthodontics, Implant Prosthodontics, Dental Material

Pei-Ling Lai, DDS, MS, PhD

Attending Staff, Division of Prosthodontics, Department of Dentistry, Kaohsiung Medical University Hospital
Field of interest: Fixed Prosthodontics, Dental Materials

Jing-Rong Lin, DDS

Attending Staff, Division of Prosthodontics, Department of Dentistry, Chi Mei Medical Center, Tainan, TaiwanField of interest: Fixed and Removalble Prosthodontics, Implant Prosthodontics.

Yi-Hao Lan,DDS, MS.

Visiting Staff, Division of Prosthodontics, Department of Dentistry, National Taiwan University Hospital.
Field of interest: Fixed and Removable Prosthodontics, Implant Prosthodontics, Digital Dentistry

Tai-Min Lin, DDS, MS

Assistant professor, Chang Gung Memorial Hospital
Director, General Dentistry Department, Taipei Chang Gung Memorial Hospital
Field of interest: Fixed and removable prosthodontics, Esthetic Dentistry, Implant Prosthodontics.s.

Min-Chieh Chang, DDS, MDsc

Adjunct Visiting Staff, Division of Prosthodontics, Department of Stomatology, National Cheng Kung University Hospital. Field of interest: Fixed and Removable Prosthodontics, Implant Prosthodontics, DigitalDentistry, Dental material.

Chih-Wen Cheng, DDS

Assistant Professor, School of Dentistry, Chung Shan Medical University, Taichung, Taiwan
Attending Staff, Division of Prosthodontics, Department of Dentistry, Chi Mei Medical Center, Tainan, Taiwan
Field of interest: Fixed prosthodontics, Implant Prosthodontics, Digital Dentistry

Ya-Yi Chen, DDS, MS, FICD

Chair, Department of Stomatology, Tungs'Taichung Metroharbor Hospital,Taichung, Taiwan
Field of interest: Fixed and Removable Prosthodontics, Implant prosthodontics

Sheng-Wei Feng, DDS, MS, PhD

Professor, School of Dentistry, College of Oral Medicine, Taipei Medical University, Field of interest: dentalimplant, tissue engineering, regenerative medicine

Sung-Ying Ye, DDS

Attending Staff, Division of Prosthodontics, Department of Dentistry, Chi Mei Medical Center, Tainan, Taiwan
Field of interest: Fixed and Removalble Prosthodontics, Implant Prosthodontics, Digital Dentistry

Shiu-Fong Ou, DDS, MS

Attending Staff, Prosthodontic Department, National Taiwan University Hospital, Taipei, Taiwan
Field of interest: Fixed and Removable Prosthodontics, Implant Prosthodontics, Digital Dentistry

Wei-Ting Lee, DDS

Attending Staff, Division of Prosthodontics, Department of Stomatology, National Cheng Kung University Hospital Field of interest: Fixed and removable prosthodontics, Esthetic Dentistry, Implant Prosthodontics

Feng-I Chen, DDS

Attending Staff, Division of Prosthodontics, Department of Dentistry, Kaohsiung Medical University Hospital,Kaohsiung, Taiwany

Subscription：USD $100/ year　訂價年費：NT $3000（四期）
創刊日期：2012年4月
出版者：中華民國贋復牙科學會　學會地址：105台北市復興北路465號2樓　學會電話：+886-2-2546-8834
學會傳真：+886-2-2546-9157　學會官網：http://www.prosthod.org.tw
ISSN 2304-5418
承製編印：美艾聯和股份有限公司　地址：235 新北市新店區中央四街91號　電話：+886-2-2219-4719
E-mail：support@novaisedit.com　傳真：+886-2-2219-4746

※贋復學會版權所有禁止拷貝

Journal of Prosthodontics and Implantology

Table of Contents

※贋復學會版權所有禁止拷貝

Journal of Prosthodontics and Implantology

Editorial

We are excited to announce the forthcoming issue of JPI March, 2024. As we navigate the post-pandemic world, our journal remains dedicated to delivering top-notch content to our audience. This edition features two original studies and two case series, highlighting research on implant screw torque values and the stability of artificial tooth staining. Furthermore, this volume introduces two case articles highlighting the innovative use of PEEK frameworks in implant-supported prostheses and the exceptional application of SLM in full-mouth reconstruction with telescopic crowns. These additions aim to keep our readers informed about the forefront of full-mouth rehabilitation techniques.

Our team is committed to offering a venue for the dental community to exchange knowledge, insights, and experiences in the wake of the pandemic. We strive to uphold the highest standards of quality in our content and encourage feedback and suggestions from our readers to help us adapt to the dynamic field of prosthodontics in Taiwan.

The Academy of Prosthetic Dentistry R.O.C., Taiwan

Li-Deh Lin, Editor-in-Chief

※贋復學會版權所有禁止拷貝

Original Article

Evaluation of original and non-original abutment screw with reverse torque values after dynamic loading: an in-vitro study

Chia-Chen Chang, DDS, MDS[ab]
Hung-Shyong Chen, MS[c]
Aaron Yu-Jen Wu, DDS, MS[d*]

[a]Department of Dentistry, Kaohsiung Chang Gung Memorial Hospital
[b]Department of Dentistry, Kaohsiung Municipal Feng Shan Hospital-Under the management of Chang Gung Medical Foundation.
[c]Department of Mechanical Engineering, Cheng Shiu University, Kaohsiung 833, Taiwan
Center for Environmental Toxin and Emerging-Contaminant Research, Cheng Shiu University, Kaohsiung 833, Taiwan
[d]Department of Dentistry, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Kaohsiung, Taiwan.

Running title: reverse torque using different screws

[*]Corresponding author:
Aaron Yu-Jen Wu, DDS, MS
Department of Dentistry, Kaohsiung Chang Gung Memorial Hospital
No. 123, Ta-Pi Road, Kaohsiung 833, Taiwan
Tel : +886-7-7317123 ext 2378
Fax: +886-7-7317123 ext 8288
Email: dentwu@hotmail.com

DOI: 10.6926/JPI.202403_13(1).0001

Abstract

Objective: *This in vitro study aimed to assess how eccentric cyclic loading affects abutments and screws in internal hexagon implant systems from different manufacturers.*

Materials and methods: *The internal hex implant system, Biomet 3i, was tested. The experiments were performed using original screws, replica screws, original abutments, and replica abutments. Nine combinations (three samples from each of three groups) were assessed. The implant body was firmly held in a special jig and the abutment screws were tightened to the manufacturers' recommended torque with a digital torque gauge. A cyclic loading of 400 N was applied at 30 degrees to the implant for 50,000 cycles. The reverse torque value (RTV) of the abutment screw was measured before and after the loading process. The data were analyzed with one-way analysis of variance and post hoc tests, with the significance level set to $P < 0.05$.*

Results: *The post-loading RTV was significantly higher than the initial pre-loading RTV. The groups with original abutments and replica screws had the highest RTV whether measured before or after loading.*

Conclusions: *This study shows that the screw material has an impact on the RTV. Scanning electron microscopic(SEM) analysis showed that the replica screws were made of a material similar to that of the original screws. The test groups using replica screws demonstrated higher RTV than those using original screws. Therefore, replica screws could be an alternative for clinical use.*

Key words: Dental implant screw fracture, reverse torque value, non-original, original, screw

Introduction

Dental implant treatment has greatly improved the edentulous patient's masticatory, aesthetic, and phonetic functions compared to traditional prostheses.[1,2] Implant technology certainly provides better options for clinicians and patients. However, for implantologists, implant screw loosening or fracture is a difficult clinical complication to deal with when making a single implant-supported prosthesis. In addition, longitudinal follow-up studies show that abutment screw loosening is surpassed by loss of osseointegration as the main cause of failure of implant-supported restorations.[3] In previous studies, the rate of incidence of abutment screw loosening reached 5.3% in the first year

※贋復學會版權所有禁止拷貝

after loading[4] and 5.8–12.7% after the five-year follow-up.[5] Dental implant screw loosening and fracture complications can be as high as 45% over a 10-year period. Such loosening is an indicator of inadequate biomechanical design and/or occlusal overload.[6]

An important mechanical factor that prevents abutment screw loosening and fracture is screw joint preload. When the screw is tightened, tension force is generated between the abutment and inner connector of the implant along the screw thread surfaces; this force is a direct determinant of clamping force.[7] The optimum preload of the screw is generally believed to occur when the screw is elongated without exceeding its yield strength. The preload is related to the implant screw material. The most common materials for dental screws are titanium and gold alloys. The friction between the metallic surface of screws and abutments reduces the preload; therefore, lubrication or gold-coated abutment screws are commonly used to minimize the preload loss.[8]

Because of the current advancements in replication technology, such as CAD/CAM , replica screws or abutments provide the benefits of cost saving and accessibility to clinical dentists. Park et al.[9] compared the torque loss of four abutment groups and found that the torque loss of the original abutments was significantly lower than that of the imitations. Alonso-Pérez et al.[10] found that the internal fit of the connection was crucial to the mechanical behavior of the assembly and suggested that the original components could be surpassed . However, there is little discussion in the literature about the feasibility of original screws or non-original screws for implant treatments. The purpose of this in-vitro study was to evaluate the performance of screws and abutments from different manufacturers by comparing reverse torque values (RTVs) before and after loading.

Material & methods

The imitation screws and abutments in the experiment were from aftermarket manufacturers (JingGang, Tainan, Taiwan). Implants (ϕ 4.1 × 10 mm Osseotite®, Biomet 3i, USA) and screws (Gold-Tite®, 3i Implant Innovations, Inc. West Palm Beach, FL, USA) were selected. Then, the test groups were divided into three smaller sub-groups: IA was the control group using an original titanium

Figure 1. Digital torque gauge (TOHNICHI BTGE50CN-G) (Tokyo, Japan, Tohnichi Mfg.)

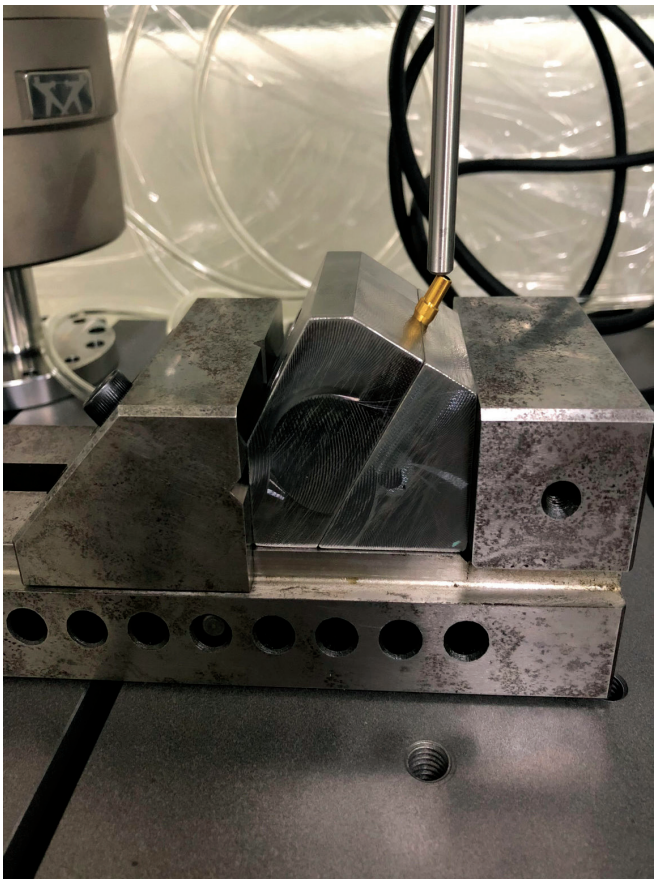


Figure 2. Testing machine (INSTRON E3000) (Norwood, MA, USA, Instron corporation)

※贋復學會版權所有禁止拷貝

alloy abutment and original screw; the IB group used an original titanium abutment with a factory-replicated screw; and the IC group used a factory-replicated titanium abutment with a factory-replicated screw. Each sub-group was measured three times to obtain a total of nine samples.

The RTVs of each set of samples were recorded before applying the load with a torque wrench with 20 N-cm torque to tighten the implant abutment screw and after 10 minutes, to re-tighten it again at the same torque value. Then, after another 5 minutes, a digital torque meter (Fig. 1) was used to measure the peak of the RTV, defined as RTV (T), prior to applying stress.

Each set of samples was fixed with a metal jig, and a force was applied using a servo-driven load cell-type testing machine (Fig. 2). At room temperature, a cyclic load of 400 N was applied to the test groups at a tilted direction of 30 degrees. The load was applied at a frequency of 2 Hz for a total of 50,000 cycles. After the cyclic load process was completed, RTV (T) was measured with the same digital torque meter after applying the load.

Statistical analysis

The factors associated with changes in RTV were statistically analyzed at an alpha value of 0.05. Linear model analysis was performed for all RTVs measured for each sample. One-way analysis of variance (ANOVA) and post hoc tests were also performed to examine the effects of screws and abutments from different manufacturers on the RTV before and after loading. The Sphericity Assumed Test was performed to examine the changes in the RTV prior to and following cyclic loading in the 3i test groups.

Results

The abutments and screws, including their surfaces and cross-sections, were analyzed using energy-dispersive X-ray spectroscopy (EDS) (JEOL Ltd., Ota, Tokyo, Japan). The composition of their materials is shown in Table 1.

Table 2 shows the RTVs before and after loading measured with a digital torque meter. The RTV (T) of all test samples prior to applying stress was less than the original tightening torque value of 20 N. Group IB (original abutment/duplicated screw) showed the highest T value, followed by group IC (duplicated abutment/duplicated screw). Group IA (original abutment/original screw) had the smallest T values, which were almost reduced by half (45%). ANOVA showed a statistically significant difference in the RTVs before loading between the three groups ($P < 0.001$).

Table 1. Material Composition of Biomet 3i® Abutment and Screw/ Duplicated Abutment and Screw

Biomet 3i®	Material Composition (%)
Original abutment	Ti87% Al8% Si2% V3%
Duplicated abutment	Ti87% Al9% Si1% V2%
Original screw (section)	Fe60% Cr20% Ni13% Mo3% Mn2% Si2%
Original screw (surface)	Au85% Fe3% C10% Cr2%
Duplicated screw	Ti89% Al7% Si1% V1%

Table 2. Initial and post-loading reverse torque values (RTV) of Groups, and the differences between initial and post-loading RTV

Group	Implant system	Abutment/Screw	Applied torque	Initial RTV Ncm(%)	Post-loading RTV Ncm (%)	Difference between initial and post-loading RTV (Ncm)
IA	3i®	Original/original	20	9.13(45%)	12.56(62%)	3.43
IB	3i®	Original/duplicated	20	15.57(77%)	19.58(96%)	4.01
IC	3i®	Duplicated/duplicated	20	13.17(68%)	16.16(84%)	2.99

Unit: Ncm, ( ): Percentage Change

※贋復學會版權所有禁止拷貝

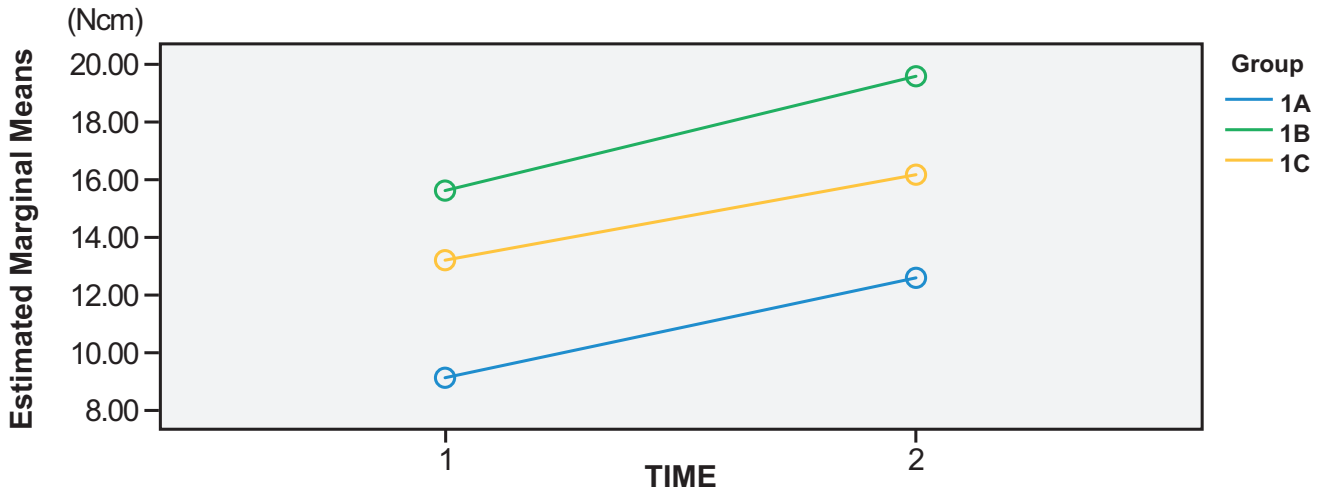


Figure 3. Distribution of reverse torque value before and after loading of 3I group. Time 1: Before loading, Time 2: After loading

The RTVs were higher after the mechanical loading process than before loading. The RTV (T) after loading differed significantly between the three groups ($P < 0.001$). The RTV (T) of IB was the highest, followed by that of IC, with IA having the lowest value. The RTV of IA before loading was 45% of the set value (20 N), and it increased by 17% after loading.

The results of ANOVA to evaluate the differences between test sets showed that RTV differed significantly between pre-loading and post-loading. The post-loading RTV was significantly greater than the pre-loading RTV (Fig. 3). Post hoc tests showed that the RTV differed significantly between the three sub-groups both before and after loading ($P < 0.05$).

Discussion

According to Bickford,[11] the screw loosening process has two stages. The first stage is initial tensile deformation of the screw, leading to a reduction in the clamping force. In the second stage, as the clamping force is further reduced, the fretting of the implant abutment interface intensifies, resulting in an unstable connection and ultimately screw loosening. Currently, two methods are described in the literature to estimate the preload force. One method uses a tension machine to measure the tension force generated by the tightening of the screw.[8] Although this method is more accurate, detectors cannot be fitted on the actual implant surface due to size constraints. Most researchers believe that the preload force and screw-tightening torque forces are closely correlated. Therefore, the common practice is to use the RTV to assess the change in the preload force. Some researchers[12, 13, 14, 15] have suggested that the screw should be retightened after the initial tightening in order to reduce the preload loss caused by the creeping movement of all the metal-contacting surfaces after being tightened together by the screw. This study also performed the procedure for retightening the screw with 20 N-cm torque 10 minutes after the first tightening.

During the experiment, all samples had a pre-loading RTV lower than the applied locking force of 20 N-cm. We accounted for the settling effect by relocking the screw after 10 minutes of the initial tightening. This phenomenon occurred because the friction between the abutment and the screw or the friction between the screw and the internal interface of the implant, as well as the resilience of the metal material, offset part of the applied force.

It is generally believed that a smaller friction coefficient of the screw results in higher preload with the same settling torque,[8] so coated screws or lubricants, like Gold-Tite® Screw, are used. However, our study found that the RTV of group IA (original abutment and original screw) was the lowest among the three groups, both before and after loading. These results are similar to the findings of Tsuge and Hagiwara,[7] but different from those of Martin et al.,[16] who reported that preload in gold alloy abutment screws was significantly greater than that in titanium alloy abutment screws. The gold alloy abutment screws used in the two studies might have had some differences. This study analyzed the surface and inner layer of screws and abutments using SEM and EDS. The surface area of the Gold-Tite® screw was coated with gold, but internally it was mainly composed of iron and chromium. The composition of the screws also differed between the two studies. The screw used in Martin et al.'s study contained 80% Pd alloy,

※贋復學會版權所有禁止拷貝

whereas the screw used in Tsuge and Hagiwara's study was composed of 60% Au alloy. However, our results showed that the pre-loading RTV of gold-coated abutment screws dropped significantly compared to the original locking force (45%). We believe that the gold coating on screws prevented preload loss by reducing friction between the screw and abutment during tightening. However, it also decreased removal torque due to less wear.

The SEM analysis shows that our replica screws and Tsuge and Hagiwara's titanium alloy screws were composed of very similar materials. Therefore, if the material compositions of screws, such as titanium alloy screws and replica screws, are highly similar, their RTV data would be closely matched. Of course, third-party mechanical manufacturing capability would also have to be better or similar to the capabilities of the manufacturers of the original screws.

According to Huang et al.,[17] structural variability of the abutment may influence the stability of the implant abutment connection and, thus, preload loss. This would eventually lead to screw loosening. In the case of implant abutment materials, Jo et al.[18] compared the stability of joints made of three different titanium alloys. The preload and compressive bending strength values were significantly higher in the group made with Ti-6Al-4V compared to those made with pure grade 3 titanium or pure grade 4 titanium. Jo et al. analyzed abutment components, both original and duplicated, made of Ti-6Al-4V. Results showed original abutments had better preload stability than duplicated ones. In Park et al.'s study,[9] the removal torque of the original Straumann abutment was significantly higher than those of the copy abutments. Alonso-Pérez et al.[10] also showed that the internal fit of the connection was crucial to the mechanical behavior of the assembly, so the original components were superior.

Conclusions

The factors that contribute to the loosening of screws in implant abutment components are complex and include abutment connector and screw design, material, tightness, additional torque magnitude, and biomechanical factors. Loosening torque values in the laboratory are for informational purposes only and do not represent the actual clinical situation. This study aimed to determine whether parts manufactured by replication methods can be used clinically. The quality of original factory abutments is relatively stable, and titanium alloy screws present stable reverse torque values under both initial- and post-loading conditions.

※贋復學會版權所有禁止拷貝

References

1. Ring ME. A thousand years of dental implants: A definitive history—Part 1. Compend Contin Educ Dent 1995;16:1060, 1062, 1064.
2. Bornstein MM, Halbritter S, Harnisch H, Weber HP, Buser D. A retrospective analysis of patients referred for implant placement to a specialty clinic: Indications, surgical procedures, and early failures. Int J Oral Maxillofac Implants 2008;23:1109–16.
3. Hoyer SA, Stanford CM, Buranadham S, Fridrich T, Wagner J, Gratton D. Dynamic fatigue properties of the dental implant-abutment interface: joint opening in wide-diameter versus standard-diameter hex-type implants. J Prosthet Dent 2001;85:599-607.
4. Pjetursson BE, Thoma D, Jung R, Zwahlen M, Zembic A. A systemic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) after a mean observation period of at least 5 years. Clin Oral Implants Res 2012;23 Suppl 6:22-38.
5. Pjetursson BE, Brägger U, Lang NP, Zwahlen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs). Clin Oral Implants Res 2007;18 Suppl 3:97-113.
6. Patterson EA, Johns RB. Theoretical analysis of the fatigue life of fixture screws in osseointegrated dental implants. Int J Oral Maxillofac Implants 1992;7:26–33.
7. Tsuge T, Hagiwara Y. Influence of lateral-oblique cyclic loading on abutment screw loosening of internal and external hexagon implants. Dent Mater J 2009;28:373–81.
8. Stüker RA, Teixeira ER, Beck JC, da Costa NP. Preload and torque removal evaluation of three different abutment screws for single standing implant restorations. J Appl Oral Sci 2008;16:55-8.
9. Park JM, Baek CH, Heo SJ, et al. An in vitro evaluation of the loosening of different interchangeable abutments in internal-connection type implants. Int J Oral Maxillofac Implants 2017;32:350-5.
10. Alonso-Pérez R, Bartolomé JF, Ferreiroa A, Salido MP, Pradíes G. Original vs. non original abutments for screw-retained single implant crowns: an in vitro evaluation of internal fit, mechanical behavior and screw loosening. Clin Oral Implants Res 2018;29:1230-8.
11. Bickford J. An introduction to the design and behavior of bolted joints. 4th ed., CRC Press., New York, 1995; pp 24-35.
12. Haack JE, Sakaguchi RL, Sun T, Coffey JP. Elongation and preload stress in dental implant abutment screws. Int J Oral Maxillofac Implants 1995;10:529-36.
13. Binon PP. The external hexagonal interface and screw joint stability: a primer on threaded fasteners in implant dentistry. Quint Dent Technol 2000;23:91-105.
14. Barbosa GA, Bernardes SR, das Neves FD, Fernandes Neto AJ, de Mattos Mda G, Ribeiro RF. Relation between implant/abutment vertical misfit and torque loss of abutment screws. Braz Dent J 2008;19:358-63.
15. Spazzin AO, Henrique GE, Nóbilo MA, Consani RL, Correr-Sobrinho L, Mesquita MF. Effect of retorque on loosening torque of prosthetic screws under two levels of fit of implant-supported dentures. Braz Dent J 2010;21:12-7.
16. Martin WC, Woody RD, Miller BH, Miller AW. Implant abutment screw rotations and preloads for four different screw materials and surfaces. J Prosthet Dent 2001;86:24-32.
17. Huang Y, Wang J. Mechanism of and factors associated with the loosening of the implant abutment screw: A review. J Esthet Restor Dent 2019;31:338–45.
18. Jo JY, Yang DS, Huh JB, Heo JC, Yun MJ, Jeong CM. Influence of abutment materials on the implant-abutment joint stability in internal conical connection type implant systems. J Adv Prosthodont 2014;6:491-7.

※贋復學會版權所有禁止拷貝

Original Article

Influence of surface sealant agent on the color stability of denture teeth

Keng-Yu Cheng, DDS, MS[a]
Chun-Nan Lin, DDS, MS[b]
Liy-Yin Huang, MS[c]
Peng, Chiao-Yun ,MS[d]

[a]Resident Doctor, Division of Prosthodontics, Department of Dentistry, Shin Kong Wu Ho-Su Memorial Hospital, Taipei, 11101, Taiwan.
Tel: +886-2-2833-2211 ext. 2170

[b]Visiting Doctor, Dental Department, Shin-Kong Wu Ho-Su Memorial Hospital, Taipei, Taiwan
No.95, Wen Chang Road, Shih Lin District, Taipei city, 11101, Taiwan

cDental technician, Dental Department, Shin-Kong Wu Ho-Su Memorial Hospita l, Taipei, 11101, Taiwan.

[d]Dental technician, Dental Department Shin-Kong Wu Ho-Su Memorial Hospital Taipei, Taiwan

Running title: Surface Sealant and Denture Teeth Color Stability

*Corresponding author:
Chun-Nan Lin, DDS, MS
Visiting Doctor, Dental Department, Shin-Kong Wu Ho-Su Memorial Hospital, Taipei, Taiwan
No.95, Wen Chang Road, Shih Lin District, Taipei city, 11101, Taiwan
Tel: +886-2-2833-2211 ext. 2170
Email: lcn1124@yahoo.com.tw

DOI: 10.6926/JPI.202403_13(1).0002

Abstract

Background/purpose: *Although various surface sealant agents are available for chairside or laboratory polishing procedures, their effect on the color stability of denture teeth is not clear. The purpose of this in vitro study was to evaluate the effect of sealant agents on the color stability of various denture tooth materials.*

Materials and methods: *40 specimens were prepared for each type of PMMA denture tooth material (SR Vivodent PE, Fx, EFUCERR-A). The specimens were assigned to 4 groups according to the surface treatment used (n=10): no surface treatment, conventional laboratory polishing technique, surface sealant agents Palaseal (Heraeus Kulzer GmbH) and surface sealant Optiglaze (GC Corp). After surface treatment were completed, specimens were immersed in coffee for 15 hours and were rinsed with running water and air-dried. Each group were then rinsed with distilled water for 8h. This cycle was repeated 42 times. The CIELab color parameters measured with spectrophotometer were performed every 7 cycles until 42 cycles were finished. Data were statistically analyzed with Generalized Estimating Equation(GEE). The significance level was 0.05.*

Results: *Optiglaze coating after grinding in SR vivodent S PE group and in Fx group would be more acceptable in color stability than coating with Palaseal after grinding by the naked eye after 6 weeks. In EFUCERR-A group, no matter which surface treatment was used, the color change would be acceptable by the naked eye after 6 weeks.*

Conclusions: *Type of teeth and surface coating with Palaseal have significant influences on color stability. Surface treatment agent may have the potential to reduce the occurrence of staining.*

Key words: denture, staining, surface sealing agent

Introduction

Removable prostheses can be used to restore the function and esthetic of edentulous areas. The components of removable prostheses include the denture base and artificial teeth. The characteristics of artificial teeth must meet some criteria,

※贋復學會版權所有禁止拷貝

including wear resistance and esthetic. Polymethyl methacrylate (PMMA) and porcelain are two materials currently used for removable prostheses.[1] Porcelain has better wear resistance, esthetic, and anti-discoloration than PMMA. However, it is hard to complete occlusal adjustment during the denture workflow. Therefore, PMMA has become the common material used for artificial teeth. The wear resistance of PMMA can be improved by adding an inorganic filler.[2,3]

Besides wear resistance, long-term color stability is important for denture teeth to maintain the esthetic.[4] Daily consumption of staining beverages such as tea, coffee, and red wine can discolor artificial teeth, leading to aesthetic concerns.[5] Increasing the color stability of artificial teeth is an important consideration in dental prosthetics. Various methods have been proposed to enhance color stability, including using surface sealants and fillers and modifying the material composition of artificial teeth.

This study aims to investigate the effect of various denture teeth and surface processing methods on long-term color stability. Its results can be a reference for dentists and dental technicians when polishing denture surfaces.

Materials and methods

This study used three types of commercially available denture teeth:

- SR vivodent S PE: Acrylic resin teeth with filler (Ivoclar Vivadent AG, Schaan, Liechtenstein)
- FX anterior: Acrylic resin teeth with filler (Yamahachi, Gamagori, Japan)
- Efucera-A: Composite resin teeth with filler (Yamahachi, Gamagori, Japan)

Each group comprised 120 maxillary central incisors and tooth models, with:

- Group V: Shade 1C and size A15
- Group F: Shade A2 and size S7
- Group E: Shade A2 and size T7

The groups were further divided equally into four subgroups according to surface treatment methods. The first subgroup involved no surface treatment (N), the second subgroup involved grinding followed by conventional polishing (G+P), the third subgroup involved grinding and sealing with the sealant agent Palaseal (Heraeus Kulzer GmbH, Wehrheim, Germany; G+SP), and the fourth subgroup involved grinding and sealing with the sealant agent Optiglaze (GC Corp, Tokyo, Japan; G+SO; Fig. 1).

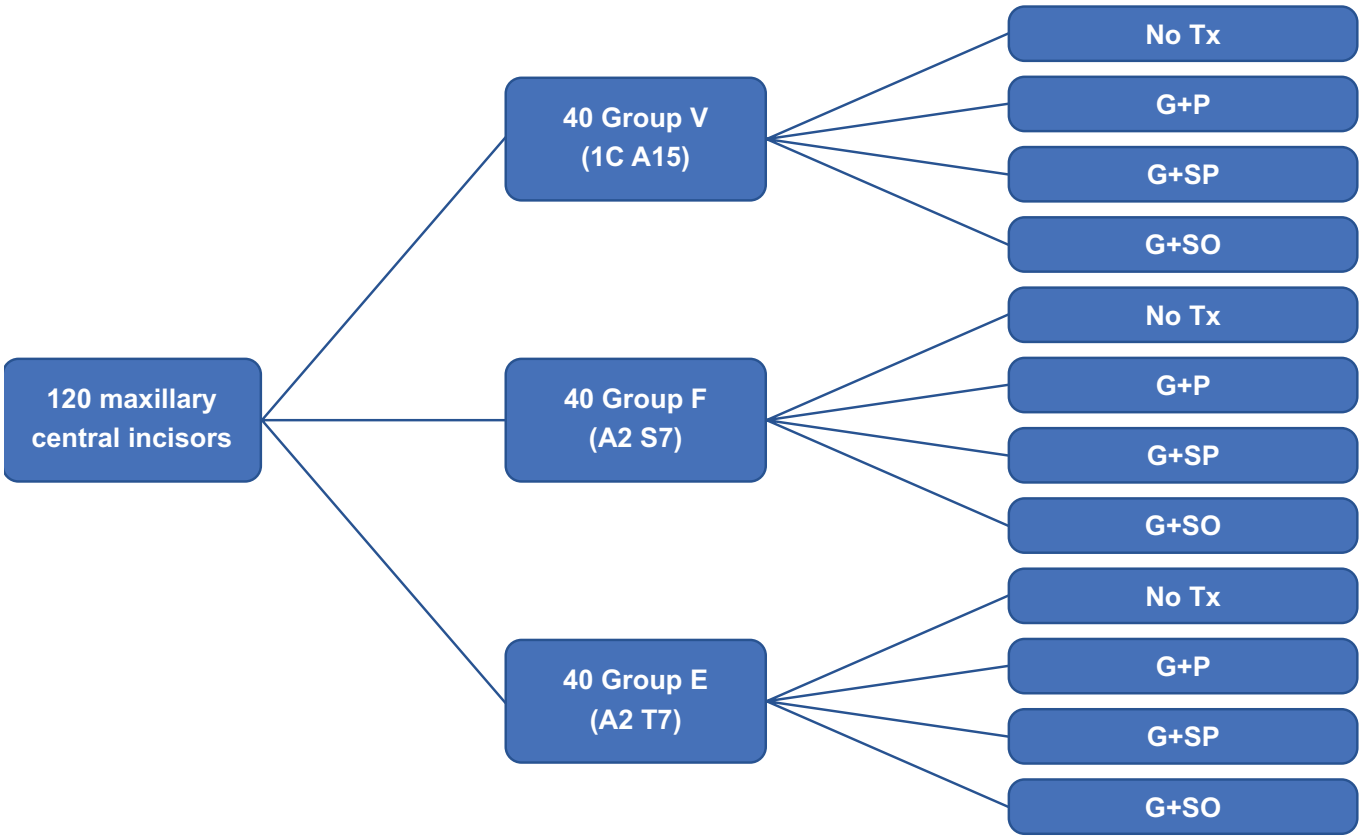


Figure 1. Distribution of denture teeth. V: SR vivodent S PE, F: Fx, E: EFUCERR-A, No Tx: no treatment, G: grinding, P: polishing, SP: Sealing agent Palaseal, SO: sealing agent Optiglaze.

※贋復學會版權所有禁止拷貝

For the grinding method, the labial surfaces of the denture teeth were ground using a Carborundum point HP#13 (Mani Inc., Kiryu City, Japan) on a straight handpiece with low speed (powered by a lab motor, UP500; URAWA Corp., Kuki, Japan) from the cementoenamel junction (CEJ) to the incisal edge, with 30 repetitions to eliminate all surface luster.

Conventional polishing consisted of three steps. Step 1 involved polishing the labial surfaces of the denture teeth using an acrylic polisher point on a straight handpiece with low speed (powered by a lab motor, UP500) from the CEJ to the incisal edge, repeated 30 times. Step 2 required polishing the labial surfaces of the denture teeth with wet pumice (coarse sand followed by wet fine sand) on a rag wheel attached to a dental lathe running at a slow speed. The teeth were lightly pressed against the wheel for 2 seconds. Step 3 applied rouge to the dry muslin buffing wheel and pressed the teeth lightly against the wheel for 2 seconds.

Regarding the surface coating procedure, Palaseal or Optiglaze was uniformly applied to the denture teeth using a soft brush. The denture teeth were allowed to dry for 20 seconds before being cured using a curing maching (Solidilite V, Shofu, Kakegawa, Japan) for 3 minutes. The same operator prepared all samples.

The samples were immersed in a coffee solution and placed in a 37°C constant temperature chamber for 15 hours in the dark to simulate the oral environment. After staining, the samples were rinsed with flowing water for 15 seconds, air-dried, and then immersed in distilled water for 8 hours. The coffee solution immersion and distilled water rinsing cycle was repeated 42 times (Fig. 2). According to the Saraç et al. study,[6] 15 hours of coffee immersion simulates the weekly exposure time to beverages or foods (2 hours × 7 days) and 8 hours of water immersion simulates overnight soaking. In this experimental design, one cycle represents one week. Since one cycle takes approximately one day, cycle 7 represents one week. Consequently, weeks 1, 2, and 6 represent 1.5, 3.0, and 9.0 months of use, respectively.

The CIE Lab* color parameters were measured and recorded using a colorimeter (VITA Easyshade; Vita Zahnfabrik, Bad Säckingen, Germany) before the experiment and after cycles 7, 14, and 42 of coffee solution immersion. The color difference (ΔE) was recorded between the pre- and post-experiment time points. A ΔE of >3.5 is easily perceived with the naked eye. A generalized estimating equation was used to investigate the effects of the type of denture teeth and surface treatment method on color stability with the SPSS statistical software (version 26.0; IBM Corp., NY, USA). A *p*-value of <0.05 was considered statistically significant.

This study used a colorimeter as the standard for color determination. Color stability studies often use colorimeters as a quantitative tool to measure the color change caused by the absorption of pigments after immersion in a colored solution. The ΔE provided by the colorimeter is an accurate and convenient way to measure color changes before and after an experiment. The colorimeter is also useful in dental clinics to help with color matching. After completing the experiment, the colorimeter retains its clinical value.

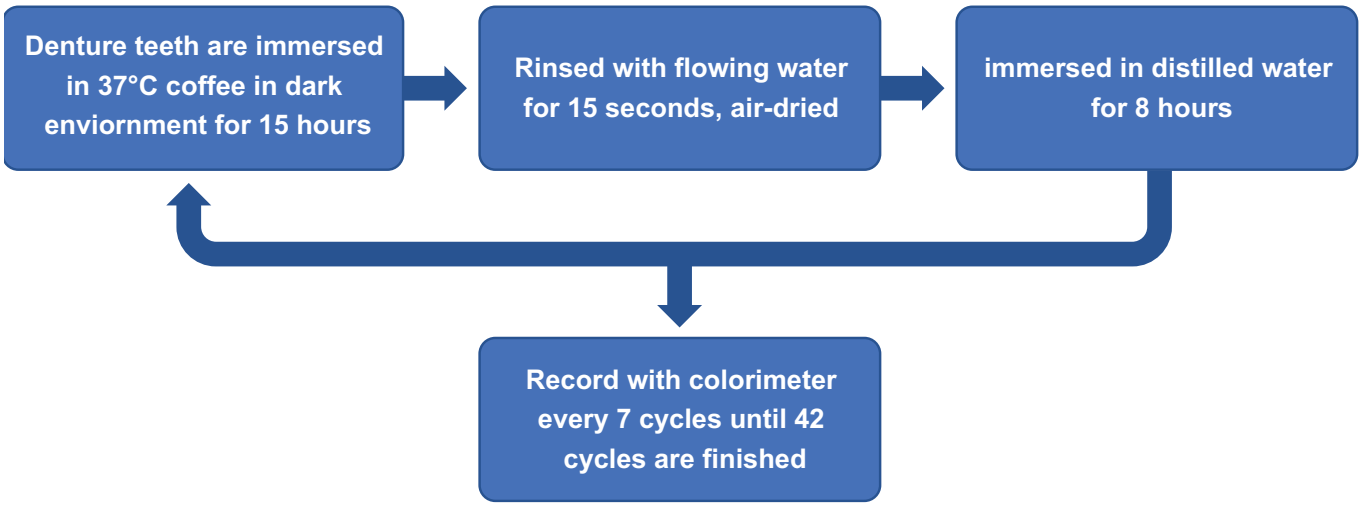


Figure 2. The process of each cycle

※贋復學會版權所有禁止拷貝

Results

The mean and standard deviation color changes (ΔE) in the 12 subgroups at one and six weeks are shown in Table 1. ΔE was calculated using the equation (ΔEab = [(L2 - L1)^2 + (a2 - a1)^2 + (b2 - b1)^2]^(1/2)), based on the lab color parameters of the upper central incisors before the experiment and at one and six weeks after.

In Group V, the mean ΔE of denture teeth at week 6 were 2.97 (±0.22), 2.89 (±0.03), 7.8 (±0.00), and 3.04 (±0.30) for the N, G+P, G+SP, and G+SO subgroups, respectively. The greatest color change was observed in the G+SP subgroup (ΔE > 3.5), followed by the G+SO (ΔE <3.5) and G+P (ΔE < 3.5) subgroups.

In Group F, the mean ΔE of denture teeth at week 6 were 0.38 (±1.20), 1.14 (±1.84), 5.10 (±0.00), and 2.60 (±1.84) for the N, G+P, G+SP, and G+SO subgroups, respectively. The greatest color change was observed in the G+SP subgroup (ΔE > 3.5), followed by the G+SO (ΔE <3.5) and G+P (ΔE < 3.5) subgroups.

In Group E, the mean ΔE of denture teeth at week 6 were 1.14 (±1.84), 1.90 (±2.00), 1.40 (±0.00), and 0.38 (±1.20) for the N, G+P, G+SP, and G+SO subgroups, respectively. The greatest color change was observed in the G+P subgroup (ΔE < 3.5), followed by the G+SP (ΔE < 3.5) and G+SO (ΔE <3.5) subgroups.

The analysis of the effect of the type of denture tooth and surface processing methods on color changes with generalized estimating equations, using Group V and group N as standard group, is shown in Table 2, and the interaction effects, using Group V+N as standard group, are shown in Table 3. Table 2 shows that when group V and group N are used as the standard groups, the color change was significantly affected by the three types of denture teeth and the denture with the Palaseal surface coating. Table 3 shows that when the group V+N is used as the standard group in comparison of the interaction, the color change was not significantly affected in Groups E+G+P and E+G+SO.

The analysis of the effect of the type of denture tooth and surface processing methods on color changes with generalized estimating equations considering an ΔE threshold of 3.5, using group V and group N as standard groups, is shown in Table 4. The color change was significantly affected by the Fx denture teeth and Palaseal coating when ΔE>3.5.

Table 1. Color changes (ΔE) at Week 1 and 6 for the three artificial tooth types, three surface treatment methods.

Color changes	SR Vivodent PE		Fx		EFUCERR-A	
(ΔE)	Week 1	Week 6	Week 1	Week 6	Week 1	Week 6
No surface treatment	2.09 (±1.97)	2.97 (±0.22)	0.76 (±1.60)	0.38 (±1.20)	1.14 (±1.84)	1.14 (±1.84)
polishing	4.00 (±0.00)	2.89 (±0.03)	1.14 (±1.84)	1.14 (±1.84)	1.90 (±2.00)	1.90 (±2.00)
Palaseal	6.16 (±1.49)	7.8 (±0.00)	3.80 (±0.00)	5.10 (±0.00)	0.00 (±0.00)	1.40 (±0.00)
Optiglaze	3.46 (±0.86)	3.04 (±0.30)	1.14 (±1.84)	2.60 (±1.84)	0.38 (±1.20)	0.38 (±1.20)

Table 2. Generalized estimating equations of the color changes (ΔE) between the three types of denture tooth and surface processing methods

Variable	B (95% CI)	p value
Type of teeth		
SR Vivodent PE	As control group	
Fx	-1.608	<0.001*
EFUCERR-A	-2.926	<0.001*
Surface treatment		
No treatment	As control group	
Convention polishing	0.588	0.112
Surface coating with Palaseal	2.360	<0.001*
Surface coating with Optiglaze	0.272	0.372

* A *P* value of <.05 denotes a significant difference.

※贋復學會版權所有禁止拷貝

Table 3. Generalized estimating equations of the color changes (ΔE) between the interaction of the types of denture tooth and surface processing methods

Variable	SR Vivodent PE		Fx		EFUCERR-A	
	B (95% CI)	p value	B (95% CI)	p value	B (95% CI)	p value
No surface treatment	As control group		-1.682	<0.001*	-1.652	0.003*
polishing	0.283	0.003*	-0.962	0.023*	-1.175	0.051
Palaseal	4.218	<0.001*	3.138	<0.001*	-4.495	<0.001*
Optiglaze	0.318	0.014*	1.257	0.008*	-1.078	0.108

* A *P* value of <.05 denotes a significant difference.

Table 4. Generalized estimating equations of the color changes (ΔE), using the color changes (ΔE)=3.5 as cutting point.

Variable	B (95% CI)	p value
Type of teeth		
SR Vivodent PE	As control group	
Fx	0.931	0.002*
EFUCERR-A	-0.838	0.118
Surface treatment		
No treatment	As control group	
Convention polishing	0.666	0.202
Surface coating with Palaseal	1.898	<0.001*
Surface coating with Optiglaze	0.335	0.502

* A *P* value of <.05 denotes a significant difference.

Discussion

This study used the CIE LAB color system[7,8] to compare color changes. According to Ghinea et al.[9], the perceptibility and the acceptability of ΔE_{ab} are 1.80 and 3.46, respectively. Clinically, a ΔE >3.5 will be unacceptable to the naked eye.[10] Our results show that the type of denture teeth and surface processing method significantly affect color stability. The color change in Group E after six weeks would not be perceived by the naked eye, regardless of which surface treatment was used.

While several factors affect the discoloration process, surface roughness is generally considered the main factor affecting stain absorption. A surface sealant is used to reduce surface irregularities and defects and enhance surface smoothness to improve stain resistance. The study by Şahin et al.[11] demonstrated that denture teeth polished using surface sealant are smoother than those polished using conventional polishing techniques. Similarly, several studies[12-15] have found that surface-penetrating sealant or glaze materials result in significantly lower roughness than conventional polishing techniques (aluminum oxide abrasive disks or silicone wheel systems). However, clinical studies have found that some removable dentures coated with surface sealant agents still experience apparent color changes in both their denture base and teeth during long-term use, contradicting the findings of previous studies.

In our study, the G+SP subgroup showed the greatest ΔE in Groups V and F, but the result differed for Group E. This result is consistent with our previous study.[16] There are several possible explanations for this difference. The compositions of surface sealants are important. Two surface sealants were used per the manufacturer's instructions, so operating errors must first be excluded. The study by Manabe et al.[17] showed that the composition of sealants can cause discoloration. Palaseal has multiple derivates from the reaction of bisphenol A and glycidyl methacrylate (GMA). Hatipoğlu et al.[18] and Fonseca et al.[19] showed that bisphenol A-glycidyl methacrylate (Bis-GMA)-based composite resins, which have higher water absorption, were more susceptible to staining. He et al.[20] and Sideridou et al.[21] also reported similar results. This finding might explain why Palaseal leads to a more apparent color change. The photoinitiator in Optiglaze is a trade secret and might explain why the Optiglaze coating shows

※贋復學會版權所有禁止拷貝

better color stability than the Palaseal coating.

The different color changes of resin teeth can be attributed to their manufacturing process and factors such as the degree of polymer conversion and the amount of remaining unreacted monomer and initiators such as dibenzoyl peroxide.[22] Water sorption of a methacrylate polymer depends on the resin network heterogeneity and its chemical structure. The hydrophilic nature of the polymer matrix could also affect water sorption of resin in the oral environment.[23] Composite resin teeth generally contain stain-causing components—urethane dimethacrylate, Bis-GMA, or a Bis-GMA analog—and filler. Kundu et al.[24] showed that hybrid composite teeth (particularly nano-filled) were more resistant to staining than acrylic teeth in staining solutions. In our study, EFUCERA-A denture teeth showed no significant color change in the Groups G+P and G+SO. The manufacturer adds a fiuorine-containing monomer, which acts as a tooth surface shield against stain-causing agents, into composite resin denture teeth to improve color stability. EFUCERA-A denture teeth can achieve good strength and color stability through this method.

Our study had some limitations. First, the temperature was constant in the thermal cycle, which differs from reality. Second, it only used a coffee solution as the staining agent, but many staining agents must be considered. Third, daily food consumption and cleaning techniques, which may make the denture teeth rougher and easier to stain, were not considered. These limitations must be considered for future studies.

Conclusions

Within the limitations of our study, the following conclusions can be made:

1. Coating SR vivodent S PE and in Fx anterior teeth with Optiglaze after grinding provides more acceptable visual color stability than coating with Palaseal after six weeks.
2. The color changes of EFUCERR-A teeth would be visually acceptable after six weeks, regardless of the surface treatment used.
3. The three types of denture teeth and Palaseal surface coating affected color changes significantly.
4. Fx anterior denture teeth and the Palaseal surface coating significantly affected ΔE when using a threshold of 3.5.

Our results show that surface treatment agents may reduce staining but also exacerbate the extent of staining after long-term use. These results can be a reference for dentists and dental technicians when choosing the surface coating on denture teeth. Future studies should examine other surface sealants and the relationship between surface treatment and color change.

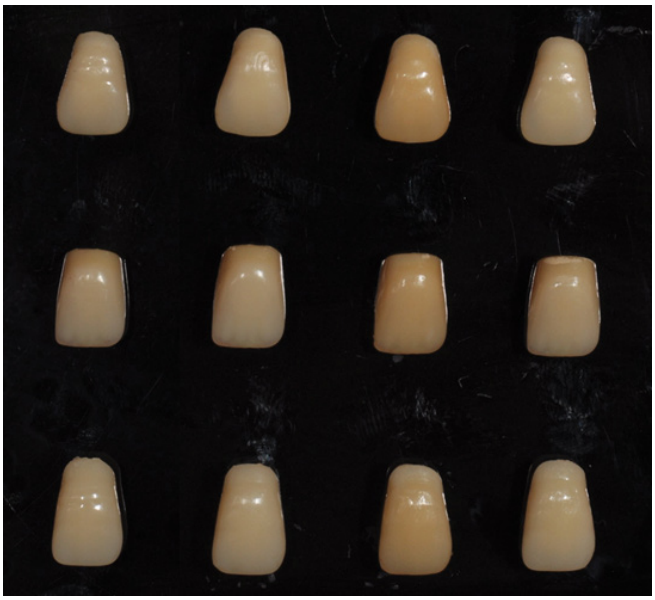


Figure 3. The groups from top to bottom are as follows: EFUCERR-A(E), SR Vivodent PE(V), Fx(F),. The groups from right to left are as follows: No surface treatment (Control), grinding and conventional polishing (G+P), grinding and palaseal (G+Ps) coating, grinding and Optiglaze (G+Og) coating.

※贋復學會版權所有禁止拷貝

References

1. Mutlu-Sagesen L, Ergun G, Ozkan Y, Bek B. Color stability of different denture teeth materials: an in vitro study. J Oral Sci 2001;43:193-205.
2. Powers JM, Sakaguchi RL. Craig's restorative dental materials. 13th ed., Elsevier, St Louis, 2012; pp 54-6.
3. Stober T, Lutz T, Gilde H, Rammelsberg P. Wear of resin denture teeth by two-body contact. Dent Mater 2006;22:243-9.
4. Gregorius WC, Kattadiyil MT, Goodacre CJ, Roggenkamp CL, Powers JM, Paravina RD. Effects of ageing and staining on color of acrylic resin denture teeth. J Dent 2012;40:47-54.
5. Imirzalioglu P, Karacaer O, Yılmaz B, Ozmen I. Color stability of denture acrylic resins and a soft lining material against tea, coffee, and nicotine. J Prosthodont 2010;19:118-24.
6. Saraç D, Saraç YS, Kurt M, Yüzbaşioğlu E. The effectiveness of denture cleansers on soft denture liners colored by food colorant solutions. J Prosthodont. 2007;16:185-91.
7. CIE (Commission Internationale de l'Eclair- age). Colorimetry-technical report. CIE Pub. No. 15. 3rd ed., Bureau Central de la CIE, Vienna, 2004; pp 16-20.
8. Hersek N, Canay S, Uzun G, Yildiz F. Color stability of denture base acrylic resins in three food colorants. J Prosthet Dent 1999;81:375-9.
9. Ghinea R, Pérez MM, Herrera LJ, Rivas MJ, Yebra A, Paravina RD. Color difference thresholds in dental ceramics. J Dent 2010;38:e57-64.
10. O'Brien WJ. Dental materials and their selection. 4th ed., Quintessence Publishing Co, Chicago, 2008; pp25-38.
11. Şahin O, Dede DÖ, Köroğlu A, Köro□lu A, Yılmaz B. Influence of surface sealant agents on the surface roughness and color stability of artificial teeth. J Prosthet Dent 2015;114:130-7.
12. Sarac D, Sarac YS, Kulunk S, Ural C, Kulunk T. The effect of polishing techniques on the surface roughness and color change of composite resins. J Prosthet Dent 2006;96:33-40.
13. Doray PG, Eldiwany MS, Powers JM. Effect of resin surface sealers on improvement of stain resistance for a composite provisional material. J Esthet Restor Dent 2003;15:244-50.
14. Köroğlu A, Sahin O, Dede DÖ, Yilmaz B. Effect of different surface treatment methods on the surface roughness and color stability of interim prosthodontic materials. J Prosthet Dent 2016;115:447-55.
15. Bertrand MF, Leforestier E, Muller M, Lupi-Pegurier L, Bolla M. Effect of surface penetrating sealant on surface texture and microhardness of composite resins. J Biomed Mater Res 2000;53:658-63.
16. Lin CN, Peng CY, Lin PY, Chang CL. Influence of surface treatment on the color stability of denture teeth. J Prosth Implant 2019;8:1-6.
17. Manabe A, Kato Y, Finger WJ, Kanehira M, Komatsu M. Discoloration of coating resins exposed to staining solutions in vitro. Dent Mater J 2009;28:338-43.
18. Hatipoğlu Ö, Turumtay EA, Saygın AG, Hatipoğlu FP. Evaluation of color stability of experimental dental composite resins prepared from bis-EFMA, a novel monomer system. J Photopolym Sci Technol 2021;34:297-305.
19. Fonseca AS, Labruna Moreira AD, de Albuquerque PP, de Menezes LR, Pfeifer CS, Schneider LF. Effect of monomer type on the CC degree of conversion, water sorption and solubility, and color stability of model dental composites. Dent Mater 2017;33:394-401.
20. He J, Kopperud HM. Preparation and characterization of Bis-GMA-free dental composites with dimethacrylate monomer derived from 9,9-Bis[4-(2-hydroxyethoxy)phenyl]fluorene. Dent Mater 2018;34:1003-13.
21. Sideridou I, Tserki V, Papanastasiou G. Effect of chemical structure on degree of conversion in light-cured dimethacrylate-based dental resins. Biomaterials 2002;23:1819-29.
22. Rosentritt M, Esch J, Behr M, Leibrock A, Handel G. In vivo color stability of resin composite veneers and acrylic resin teeth in removable partial dentures. Quintessence Int 1998;29:517-22.
23. Barszczewska-Rybarek IM. Characterization of urethane-dimethacrylate derivatives as alternative monomers for the restorative composite matrix. Dent Mater 2014;30:1336-44.
24. Kundu J, Kumar R, Seshan S. A study on evaluation of surface roughness and anti-staining propensity of nano-composite denture teeth. Int J Cur Res 2014;6:52.

※贋復學會版權所有禁止拷貝

Case Report

PEEK framework for full-mouth rehabilitation with fixed, implant-supported prostheses: a case report

Kuan-Ling Huang, DDS[ab]
Po-Kai Juan, DDS, MS[a*]
[a]Taipei Medical University Hospital Dentistry-Prosthodontic department, Taipei, Taiwan
[b]Chung Shan Medical University, Taichung, Taiwan

[*]Corresponding author:
Po-Kai Juan, DDS, MS
No.252, Wuxing St., Xinyi Dist., Taipei City, Taiwan
Tel : (02) 2737-2181 #5 #3211
Fax: (02) 2737-2181
Email: l610623@hotmail.com.tw

DOI: 10.6926/JPI.202403_13(1).0003

Abstract

An implant-supported complete arch fixed prosthesis is a viable treatment option for edentulous patients, and the stress distribution from the framework to the implant and peri-implant bone has been discussed.[1,2] Titanium or zirconia framework has a higher Young's modulus compared to polyetheretherketone (PEEK), while the tensile properties of PEEK are similar to human bone, potentially providing a shock-absorbing capacity.[3-5] However, the low Young's modulus of the PEEK may introduce greater deformation and micro-motion at the implant-bone interface.[4-6] This clinical report presents a full-mouth rehabilitation case utilizing PEEK as an implant framework material with zirconia crowns and composite resin for artificial gingiva. While PEEK is a promising framework material, it still lacks long-term clinical evidence, and further investigation is necessary before recommending its use as a non-metallic material.

Key words: polyetheretherketone (PEEK), full-mouth fixed implant-supported prostheses, veneering composite resin

Introduction

Polyetheretherketone (PEEK) is a synthetic, polymeric material that has possess unique physical and mechanical properties and can be easily modified by incorporating carbon fibers or glass fibers.[4,5] It is one of the Polyaryletherketones(PAEKs) polymer group family and the chemical structure of polyaromatic ketones confers stability at high temperatures and compatibility with many reinforcers.[4,7,8] PEEK has been proposed for a number of dental applications.[3,6,9-11] Another PEAKs family material named PEKK shares a similar chemical structure with PEEK, but replaces one of the flexible ether linkages with a more rigid ketone group, and the second ketone group is selected ortho(straight) or para(kinked) substituted.[7,8,10] Different companies have manufactured proprietary materials that contain a variety of reinforcers, such as ceramic fillers, and with patented formulations and processing protocols provided. For example, JUVORA™ PEEK(JUVORA™ PEEK, Invibio Ltd, Leeds, United Kingdom) and BioHPP (BioHPP, Bredent, Senden, Germany) were declared as products derived from PEEK and Pekkton ivory (Pekkton ivory, Cendres+Metaux SA, Bienne, Switzerland) was declared developed from PEKK. This case report describes the case using PEEK as framework material for a full-mouth implant-supported fixed rehabilitation.

※贋復學會版權所有禁止拷貝

Case Report

In August 2013, a 50-year-old female patient came to the Department of Prosthodontics of Taipei Medical University Hospital seeking evaluation for full-mouth fixed restoration. After a comprehensive examination(Fig. 1 and Fig. 2), the patient's remaining teeth were found in devastating conditions. All teeth showed severe bony destruction and mobility grade three(Miller's classification 1953)[12], the diagnosis was generalized periodontitis stage IV grade C(Staging and grading of periodontitis, Tonetti 2018)[13], and the prognosis of every single tooth was determined as hopeless(McGuire prognosis 1996)[14]. Based on cephalometric analysis, the patient had an Angle Class III malocclusion (bilateral Class III canine relationship, Angle's classification1890, and BO located ahead of AO, Wits analysis 1975) (Fig. 3)[15-16], which may compromise the clinical performance of the upper anterior implants with a conventional implant-supported "crown and bridge" design. The patient denied any drug or food allergies, had an unremarkable medical history, and denied any parafunctional habits. A fixed restoration was the only option to meet the patient's expectations, and well-established data collection was performed to assess the feasibility of implantation. After a detailed discussion, it was decided to extract all teeth that could not serve as fixed abutments due to generalized loss of periodontal support and the poor crown-to-root ratio.[17,18] The patient's residual ridge was a combined defect and was categorized as LTR Class IV.[19] The number, position, and angulation of implants were considered, and all viable treatment modalities were discussed with the patient. Finally, the definitive prosthetic treatment plan included fixed dental prostheses for both upper and lower arches, each supported by eight implants. The prosthetic design was a hybrid prosthesis, including a PEEK framework, zirconia crowns, and light-curing composite resin for the gingiva portion.

Due to the etiology stemming from periodontitis, the treatment began with disease control, followed by extraction of all hopeless teeth under sedation. Immediate dentures made by complete denture protocol were fabricated and delivered (Fig. 4). Three months later, a preliminary impression (Cavex Cream Alginate, CAVEX GmbH, Ofterdingen, Germany) was taken. Diagnostic wax-up and surgical stents were made for implants (Astra Tech Implant System TX, Dentsply Sirona, Charlotte, USA) insertion. A final impression was made with polyvinylsiloxane impression material (Aquasil, Dentsply Caulk, Charlotte, USA) and customized individual trays (Plaque Photo, Willmann & Pein GmbH, Barmstedt, Germany) after the implants achieved osseointegration(Fig. 5). Then, the implant-supported baseplates and wax rims were made for centric relation record and to determine vertical dimension and lip support. The uni-abutments (Astra Tech Implant System TX Uni Abutment, Dentsply Sirona, Charlotte, USA) were selected according to the working casts and titanium temporary cylinders were used to make verification jigs. These jigs were then used to verify that the implant positions were coincident with the analogues in the working cast by one-screw test (Fig.6). Mandible flexure was taken into consideration[20], and the lower implant-supported fixed prostheses was divided into two pieces between 43 and 44. Once the positions of the analogues were confirmed, the full-contour resin patterns (Tempron, GC Dental Products Corporation Kachigawa Plant, Kasugai-shi Aichi, Japan) were fabricated and used for clinical try-in. Afterwards, the full-contour resin patterns were cut back for the prototype of definitive frameworks. PEEK (BioHPP, bredentUK, Chesterfield, UK) was used as the final framework material, which was fabricated by a 2-press system method (Fig. 7). The prototypes were duplicated as wax patterns, which were invested and heat pressed following the instructions provided by manufacturing company(Fig. 8 and Fig. 9). The framework try-in was performed and checked both intraorally and radiographically. The passive fit of the framework was confirmed by one screw test and cleanability was also examined. Acrylic resin crowns (Tempron, GC Dental Products Corporation Kachigawa Plant, Kasugai-shi Aichi, Japan) were try-in and adjusted for optimal contours and occlusion, and used as templates for CAD/CAM permanent zirconia crowns (Ceramill CAD/CAM material, AMANN GIRRBACH, Koblach, Austria) (Fig. 10 and Fig. 11). Nano-filled light-curing composite resin (visio. lign, bredent UK, Chesterfield, UK) was applied for the artificial gingiva(Fig. 12). The surface treatment included bonding agent usage (SR Link, Ivoclar, Schaan, Liechtenstein). The framework was delivered with 15N torque, and the zirconia crowns were cemented with temporary cement, which was recommended by the manufacturer (Temp-Bond, Kerr, California, USA) (Fig. 13) (February 2016). Throughout the following years' follow-up, the full-mouth implant-supported fixed prosthesis worked functionally.

※贋復學會版權所有禁止拷貝

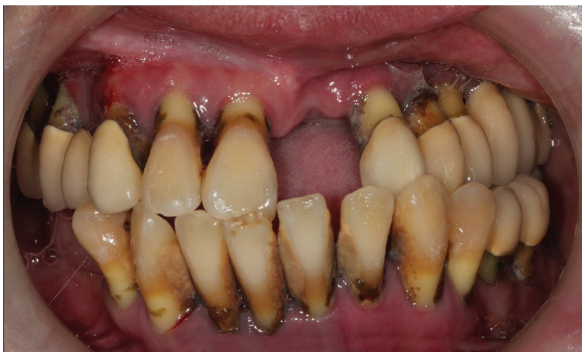


Figure 1. Initial intra-oral examination showed severe periodontitis.

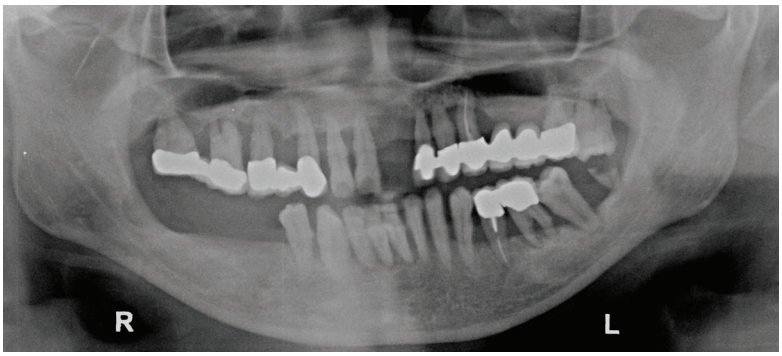


Figure 2. The panoramic film showed remaining dentition with severe bony destruction.

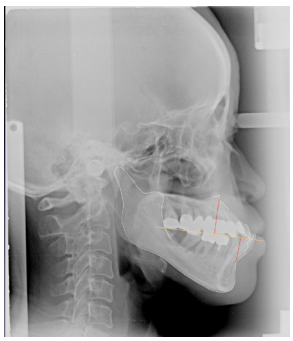


Figure 3. The cephalometric analysis indicated that the patient was Angle's Class III malocclusion.

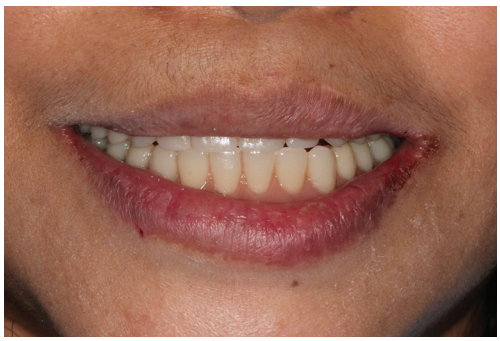


Figure 4. Immediate dentures were fabricated and delivered.

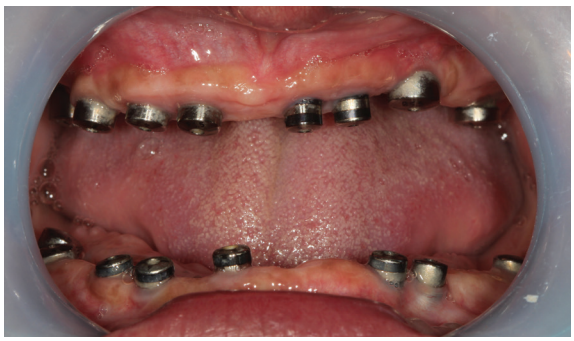


Figure 5. Upper and lower implants with healing abutments (Astra Tech Implant System TX, Dentsply Sirona, Charlotte, USA).

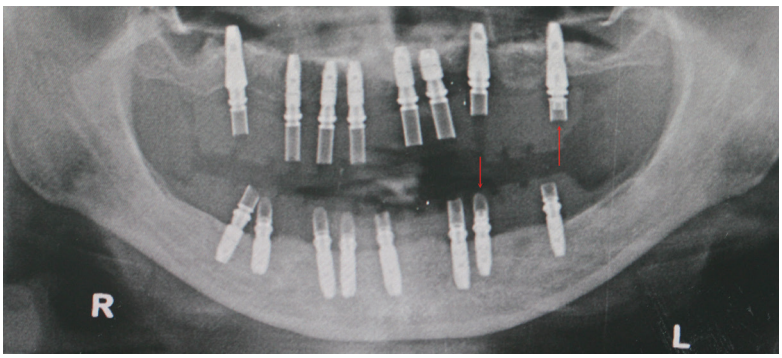


Figure 6. A panoramic film was taken for examination by one-screw test, and the arrows indicate the temporary cylinders with screws.

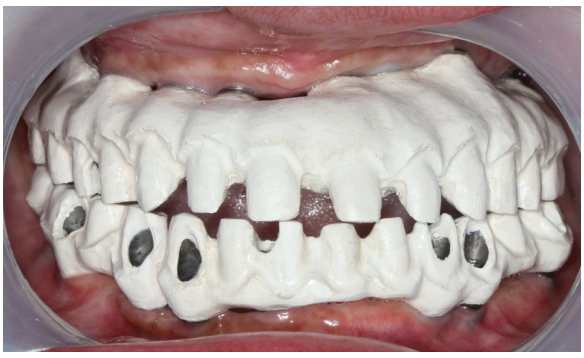


Figure 7. The PEEK framework was fabricated by a 2-press system method.

Figure 8. The wax patterns were used for investment and followed by the heat pressing procedure.

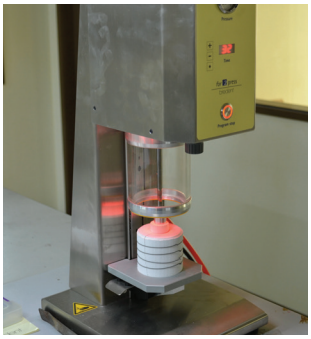


Figure 9. The heat pressing machine. (For2Press^{R} System, bredent UK, Chesterfield, UK)

Figure 10. Permanent zirconia crowns were fabricated by CAD/CAM technology.

※贋復學會版權所有禁止拷貝

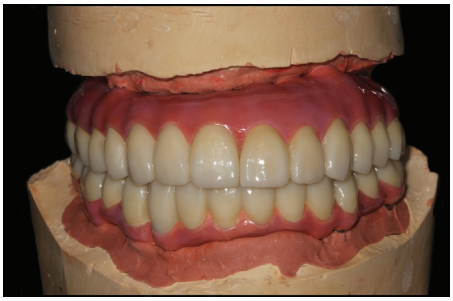


Figure 11.
Try-in of the permanent zirconia crowns on the PEEK framework.

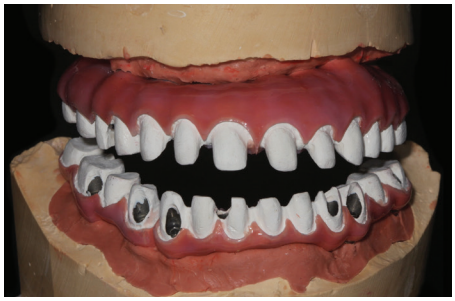


Figure 12.
The artificial gingiva was made of nano-filled light-cured composite resin (visio.lign, bredent UK, Chesterfield, UK).

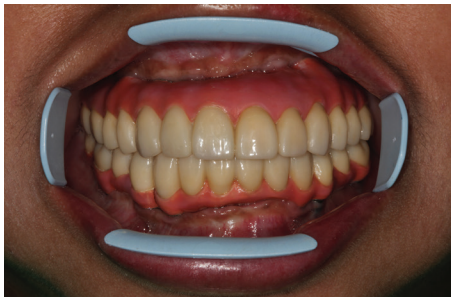


Figure 13.
Follow-up image of the implant-supported full-mouth fixed prostheses.

Discussion

It is known that Young's modulus and tensile properties of PEEK are similar to those of human bone.[3-5] Therefore, PEEK is considered to have a potential shock-absorbing capacity.[3] Han used Pekkton (Pekkton ivory, Cendres+Metaux) as an implant framework, indicating acceptable esthetic and functional results.[21] Zoidis published clinical reports utilizing PEEK implant frameworks and concluded it could be an alternative treatment.[22] Nobre published a three-year follow-up article, using PEEK as a framework in a fixed implant- supported prosthesis in conjunction with the all-on-four concept, which achieved a high prosthetic/ implant cumulative survival rate and patient satisfaction, with lower marginal bone loss and low incidence of biological complications.[3] Similar findingswere found in research published in 2018.[23]

Mechanical complications mainly occur in patients with bimaxillary rehabilitations, with implant-supported fixed prostheses in the opposing arch.[3] Although the rigidity of titanium or zirconia may cause stress concentration[24], on the other hand, the low Young's modulus of the polymeric frameworks and longer lever arms cause greater deformation and micro-motion at the implant-bone interface. Yu in 2022 suggested that zirconia and metal resulted in a more favorable distribution of stress in implants and supporting bone than polymer in a fixed implant-supported mandibular prosthesis.[6]

Research indicated a stiffer framework provides a more even distribution of forces among the bridge and abutments, decreasing the stress within the retaining screws as a result of reduced bending of the framework.[1,6] The relevant conclusions are based on finite element analysis while the clinical reports, which took advantages of PEEK, still lacked long-term follow-up.[3,5,22,23]

Another issue is the bond strength between composite resin and PEEK, which Nobre considered part of the learning curve in the manufacturing process.[3] In 2019, Jin compared BioHPP and titanium framework, and the result showed that the shear bond strength between BioHPP and composite resin is significantly higher than that between titanium and composite resin.[25] To increase the bond strength between composite resin and PEEK, Gouveia used airborne-particle abrasion with 110-μm aluminum oxide for surface treatment, which could increase the shear bond strength between veneering composite resin to PEEK and PEKK polymers and indicated the manufacturing process (milled or heat-pressed) did not significantly affect the bond strength.[26] Taha suggested combining airborne-particle abrasion with laser or plasma treatment to increase adhesion ability.[27]

Summary

The accuracy and mechanical properties are key to full-mouth fixed implant-supported prostheses. Considering the unique characteristics of PEEK[3-5,23], using this material for framework in full-mouth implant-supported rehabilitation appears to be a feasible alternative option. However, long-term studies are needed before recommending this protocol.

※贋復學會版權所有禁止拷貝

References

1. Rubo JH, Souza EA. Finite element analysis of stress in bone adjacent to dental implants. J Oral Implantol 2008;34:248-55.
2. Menini M, Pesce P, Bevilacqua M, et al. Effect of Framework in an Implant-Supported Full-Arch Fixed Prosthesis: 3D Finite Element Analysis. Int J Prosthodont 2015;28:627-30.
3. de Araujo Nobre M, Moura Guedes C, Almeida R, Silva A, Sereno N. Hybrid Polyetheretherketone (PEEK)-Acrylic Resin Prostheses and the All-on-4 Concept: A Full-Arch Implant-Supported Fixed Solution with 3 Years of Follow-Up. J Clin Med 2020;9:2187.
4. Kurtz SM, Devine JN. PEEK biomaterials in trauma, orthopedic, and spinal implants. Biomaterials 2007;28:4845-69.
5. Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. J Prosthodont Res 2016;60:12-19.
6. Yu W, Li X, Ma X, Xu X. Biomechanical analysis of inclined and cantilever design with different implant framework materials in mandibular complete-arch implant restorations. J Prosthet Dent 2022;127:783.
7. Villefort RF, Diamantino PJS, Zeidler S, et al. Mechanical Response of PEKK and PEEK As Frameworks for Implant-Supported Full-Arch Fixed Dental Prosthesis: 3D Finite Element Analysis. Eur J Dent 2022;16:115-21.
8. Alsadon O, Wood D, Patrick D, Pollington S. Fatigue behavior and damage modes of high performance poly-ether-ketone-ketone PEKK bilayered crowns. J Mech Behav Biomed Mater 2020;110:103957.
9. Sarot JR, Contar CM, Cruz AC, de Souza Magini R. Evaluation of the stress distribution in CFR-PEEK dental implants by the three-dimensional finite element method. J Mater Sci Mater Med 2010;21:2079-85.
10. Dawson JH, Hyde B, Hurst M, Harris BT, Lin WS. Polyetherketoneketone (PEKK), a framework material for complete fixed and removable dental prostheses: A clinical report. J Prosthet Dent 2018;119:867-72.
11. Crespi R, Vinci R, Cappare P, Romanos GE, Gherlone E. A clinical study of edentulous patients rehabilitated according to the "all on four" immediate function protocol. Int J Oral Maxillofac Implants 2012;27:428-34.
12. Miller SC. Textbook of periodontia (oral medicine). Blakiston; 1950; p.125.
13. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. J Periodontol 2018;89 Suppl 1:S159-72.
14. McGuire MK, Nunn ME. Prognosis versus actual outcome. II. The effectiveness of clinical parameters in developing an accurate prognosis. J Periodontol 1996;67:658-65.
15. Tang EL, Wei SH. Recording and measuring malocclusion: a review of the literature. Am J Orthod Dentofacial Orthop 1993;103:344-51.
16. Jacobson A. The "Wits" appraisal of jaw disharmony. Am J Orthod 1975;67:125-38.
17. Tada S, Ikebe K, Matsuda K, Maeda Y. Multifactorial risk assessment for survival of abutments of removable partial dentures based on practice-based longitudinal study. J Dent 2013;41:1175-80.
18. Tada S, Allen PF, Ikebe K, Zheng H, Shintani A, Maeda Y. The Impact of the Crown-Root Ratio on Survival of Abutment Teeth for Dentures. J Dent Res 2015;94:220-5.
19. Pollini A, Goldberg J, Mitrani R, Morton D. The Lip-Tooth-Ridge Classification: A Guidepost for Edentulous Maxillary Arches. Diagnosis, Risk Assessment, and Implant Treatment Indications. Int J Periodontics Restorative Dent 2017;37:835-41.
20. Fischman B. The rotational aspect of mandibular flexure. J Prosthet Dent 1990;64:483-5.
21. Han KH, Lee JY, Shin SW. Implant- and Tooth-Supported Fixed Prostheses Using a High-Performance Polymer (Pekkton) Framework. Int J Prosthodont 2016;29:451-4.
22. Zoidis P. The all-on-4 modified polyetheretherketone treatment approach: A clinical report. J Prosthet Dent 2018;119:516-21.
23. Malo P, de Araujo Nobre M, Moura Guedes C, et al. Short-term report of an ongoing prospective cohort study evaluating the outcome of full-arch implant-supported fixed hybrid polyetheretherketone-acrylic resin prostheses and the All-on-Four concept. Clin Implant Dent Relat Res 2018;20:692-702.
24. Bacchi A, Consani RL, Mesquita MF, Dos Santos MB. Effect of framework material and vertical misfit on stress distribution in implant-supported partial prosthesis under load application: 3-D finite element analysis. Acta Odontol Scand 2013;71:1243-9.
25. Jin HY, Teng MH, Wang ZJ, et al. Comparative evaluation of BioHPP and titanium as a framework veneered with composite resin for implant-supported fixed dental prostheses. J Prosthet Dent 2019;122:383-8.
26. Gouveia D, Razzoog ME, Sierraalta M, Alfaro MF. Effect of surface treatment and manufacturing process on the shear bond strength of veneering composite resin to polyetherketoneketone (PEKK) and polyetheretherketone (PEEK). J Prosthet Dent 2022;128:1061-6.
27. Taha D, Safwat F, Wahsh M. Effect of combining different surface treatments on the surface characteristics of polyetheretherketone-based core materials and shear bond strength to a veneering composite resin. J Prosthet Dent 2022;127:599.

※贋復學會版權所有禁止拷貝

Case Report

A Clinical Report of Digital Assisted Full Mouth Rehabilitation Using Zirconia Inner Crowns and SLM Titanium Framework for Fabrication of Telescopic Denture

Kai-Chun Cheng, DDS[a]
Jeh-Hao Chen, DDS, MS, PhD[ab]
Je-Kang Du,DDS, MS, PhD[ab]
Ting-Hsun Lan, DDS, MS, PhD[ab*]

[a]Division of Prosthodontics, Department of Dentistry, Kaohsiung Medical University Hospital, Kaohsiung Medical University, Kaohsiung, 80708, Taiwan.
[b]School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, Kaohsiung, 80708, Taiwan.

Running title: digital assisted telescopic denture

***Corresponding author:**
Ting-Hsun Lan, DDS, MS, PhD
School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, 100 Shin-Chuan 1st Road, Sanmin District, Kaohsiung 80708, Taiwan
Tel : +886-7-3121101 ext. 7003
Fax: +886-7-3157024
E-mail: tinghsun.lan@gmail.com

DOI: 10.6926/JPI.202403_13(1).0004

Abstract

Patients with poor occlusal support suffer from unequal bone resorption, leading to an uneven occlusal plane. A telescope overdenture could be a promising treatment option for full mouth reconstruction to maintain healthy teeth and balance the unfavorable occlusal pair. Interest in fabricating digitally assisted removable dentures has focused on using intraoral and extraoral scanners, computer-aided design software, and computer-aided manufacturing machines since they may offer faster treatment, better prosthesis fit, and ease of denture duplication. This clinical report describes a method combining digital scanning devices and a 3D milling/printing process with conventional procedures to fabricate telescope dentures for a 66-year-old male patient. The intraoral scanner helped capture the detailed surface structure of the natural abutment teeth and edentulous ridge. Interim dentures could be scanned and converted into 3D data for superimposing digital models to duplicate intermaxillary relationships. Multiple materials were applied during treatment, including zirconia inner crowns, a selective laser melting manufactured titanium metal framework, 3D-milled polymethylmethacrylate artificial teeth, and conventional denture base resin. This digitally assisted method and packing procedure provided a more efficient and precise way to fabricate telescopic overdentures. During the 1.5-year follow-up period, the patient was satisfied with his dentures, masticatory function, and improved physical appearance.

Key words: Telescopic denture, loss of occlusal support, digital assisted prostheses, zirconia, selective laser melting

Introduction

Removable prostheses are a common treatment for patients who have lost many teeth or with poor occlusal support. A telescope denture is a common option for patients with a compromised periodontal situation who wish to preserve as many healthy teeth as possible and pursue better prosthesis stability and retention.[1] A telescope denture consists of inner and outer crowns, a metal framework, artificial teeth, and a denture base. The advantages of these attachments are decreased denture size, increased retention and support, slower ridge resorption, and improved comfort.[2]

Digital dentistry has recently become popular. The use of digital equipment and computer-aided design/computer-aided manufacturing (CAD/CAM) technologies has significantly

※贋復學會版權所有禁止拷貝

improved precision and reduced the treatment period. 3D milling has developed extensively over the last decade to produce zirconia prostheses and is commonly used for dental crowns, bridges, and copings.

Regarding metal manufacture, casting difficulties have led to the limited use of titanium in dental prostheses in the past. The selective laser melting (SLM) method has recently been developed to fabricate biomedical components from titanium alloys. Polymethylmethacrylate (PMMA) resin discs can be milled into artificial teeth previously designed and adjusted in CAD software.

A new type of telescope denture can be fabricated by combining these materials. This clinical report describes and evaluates a digitally assisted process to manufacture a telescope denture for the full mouth rehabilitation of a 66-year-old male patient.

Case report

A 66-year-old male patient who attended the Department of Prosthodontics at KMU Hospital requested full mouth evaluation and rehabilitation to improve his masticatory function. The patient stated that the original upper fixed 11-X-22-23 prostheses were highly mobile, and he suffered from gingival swelling due to severe periodontitis. The bridge was removed at a local dental clinic about one month before. Clinical and radiographic evaluations revealed poor oral hygiene, multiple teeth with severe bone loss and malposition, an upper torus palatinus about 2.0 × 3.0 cm in size, an ill-fitting 45-X-47 metal bridge, unfavorable occlusal support with Eichner B3 classification, and complete anterior deep bite (Figs. 1, 2, and 3). The patient hoped to retain as many healthy teeth as possible and looked forward to good functional and esthetic outcomes. However, the patient rejected implant surgery and considered removable denture prostheses a more acceptable option. After detailed evaluation and discussion, it was decided that the telescopic type of dentures with natural teeth abutments would be a suitable treatment option.

His prosthetic treatment began by removing the 45-X-47 metal bridge and extracting the hopeless teeth (31, 32, 41, and 42). Next, a study cast and detailed wax-up were created for occlusal

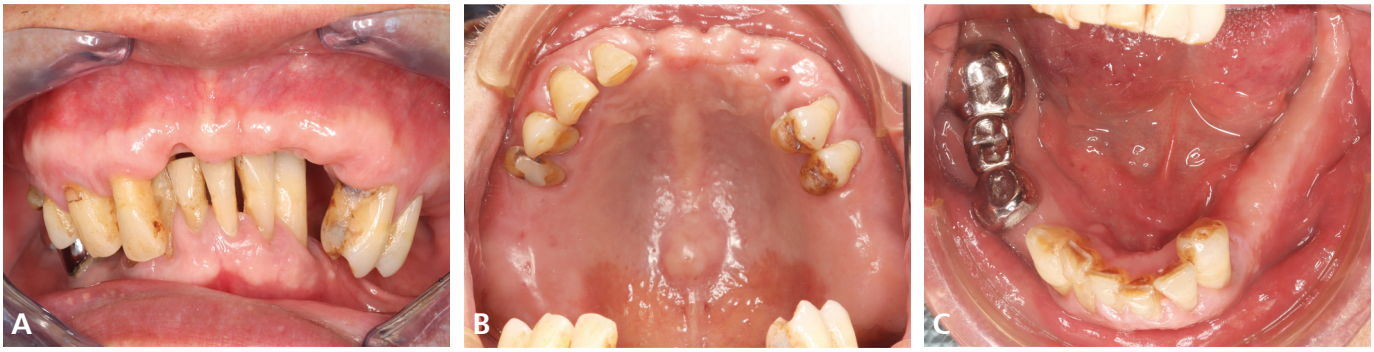


Figure 1. The patient's initial intra-oral condition. (A) Frontal view. (B) Occlusal view of the upper arch. (C) Occlusal view of the lower arch.

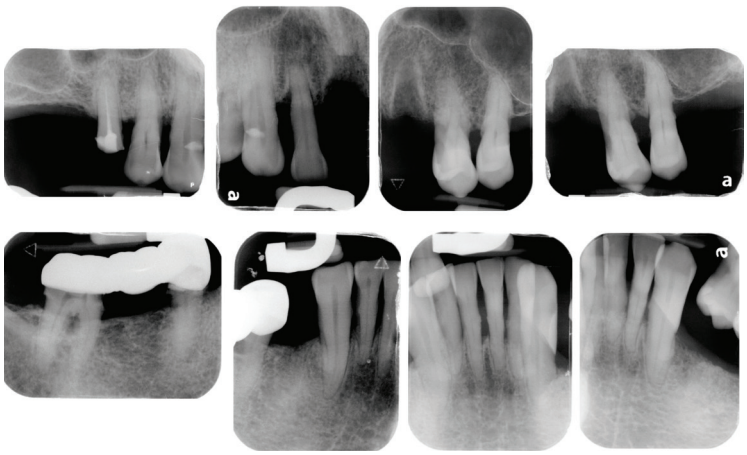


Figure 2. Periapical radiographic films showed unfavorable crown/root ratio for the remaining natural teeth and a poorly fitted 45-X-47 metal bridge

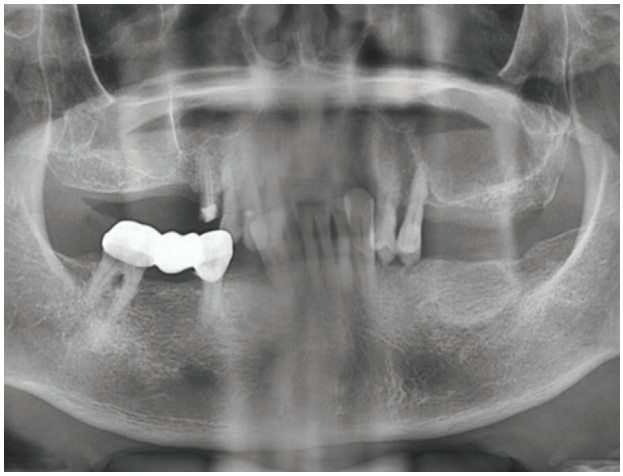


Figure 3. The patient's initial panoramic radiograph film.

※贋復學會版權所有禁止拷貝

space and occlusal plane analysis to evaluate the reduction volume of individual abutments. Then, all his other remaining teeth underwent emergency endodontic therapy followed by preparation and reduction to about 3~4 mm to attain a more ideal crown/root ratio and adequate space for prostheses material (Fig. 4). After the standard impression taking, vertical dimension and centric relation recording, and wax denture try-in, the upper and lower interim overdentures were delivered to meet basic chewing and esthetic demand (Fig. 5). It took the patient about three months to adapt to using removable dentures. The endodontic therapy for all abutment teeth was completed during this period. A thorough assessment was made to ensure those abutment teeth maintained good periodontal condition and the interim dentures worked well.

When fabricating the definitive prostheses, the inter-arch relationship, incisal display, and occlusal plane for tooth arrangement were based on the morphology of the interim dentures. An intra-oral scanner (3-shape Trios 3; 3Shape, Copenhagen, Denmark) was used for the final impression of the abutment teeth and edentulous ridge (Figs. 6A and 6B), and an extra-oral scanner (3-shape E4; 3Shape, Copenhagen, Denmark) was used to duplicate the interim dentures for the jaw relationship record. The digital data were superimposed and designed in Exocad DentalCAD (Exocad GmbH, CA, USA) software. The upper and lower digital model was "mounted" in Exocad to evaluate inter-arch space for all components needed for the definitive prostheses (Fig. 7). A digital wax-up of the upper and lower dentures was made to analyze inter-arch space and predict the future outcome of the definitive denture (Figs. 8A–B).

Zirconia was chosen for the inner crown material due to its strength, tooth-like color, and biocompatibility. The inner crowns were fabricated using a CAD/CAM milling procedure and showed identical long axes for the insertion path and a good fit under clinical examination (Fig. 9A–B). The outer crowns and denture framework were designed as a combined structure to achieve consistency and a strong connection. They were manufactured by 3D printing from metal with the SLM method and showed good accuracy in try-in appointments (Figs. 10 and 11).

The next step was to fabricate the artificial teeth. The morphology and occlusal scheme of the dentition were designed in the Exocad software and milled from a PMMA resin disc. An analysis of a digital wax-up showed that the prosthetic spaces for abutment areas 24, 25, and 47 were limited for PMMA artificial teeth. Therefore, the external surface of the outer crowns was covered with a layer of veneered hard composite resin (crea.lign light-curing veneering composite; Brendent, Senden, Germany) to construct the morphology of the premolars and second molar. Hard composite resin was superior to veneering porcelain due to its flexibility and similar hardness to opposing artificial teeth.

Then, the wax dentures were manufactured for the patient's try-in step. Finally, after the conventional packing and polishing procedure, the definitive dentures were fabricated and delivered for long-term use (Fig. 12A–F) . The patient was satisfied with the outcome of the final denture and returned for three monthly follow-ups. A panoramic radiograph showed a stable periodontal condition and tooth structure (Fig. 13). No complications occurred during the 1.5 years of use and follow-up.

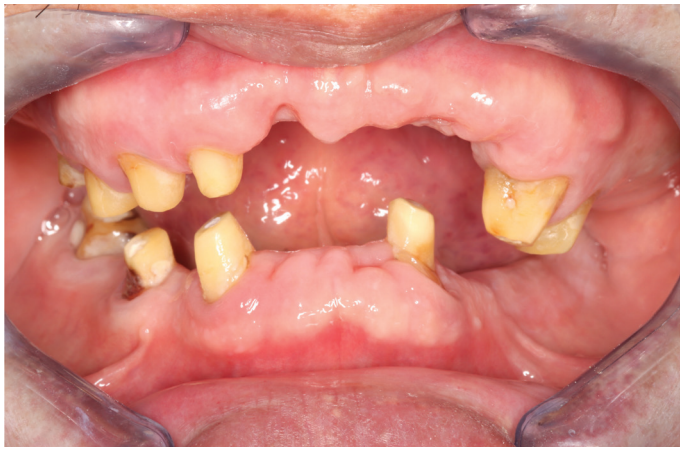


Figure 4. The old 45-X-47 metal bridge was removed, and the remaining teeth were prepared and reduced to 3~4 mm for a better crown/root ratio.

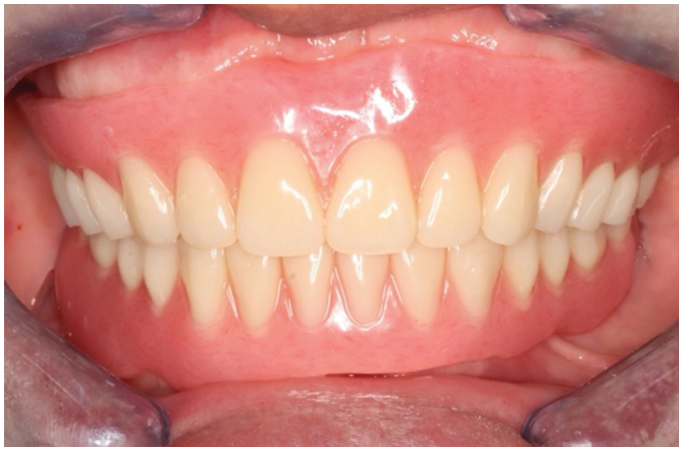


Figure 5. The upper and lower interim dentures gave the patient basic chewing and esthetic function.

※贋復學會版權所有禁止拷貝

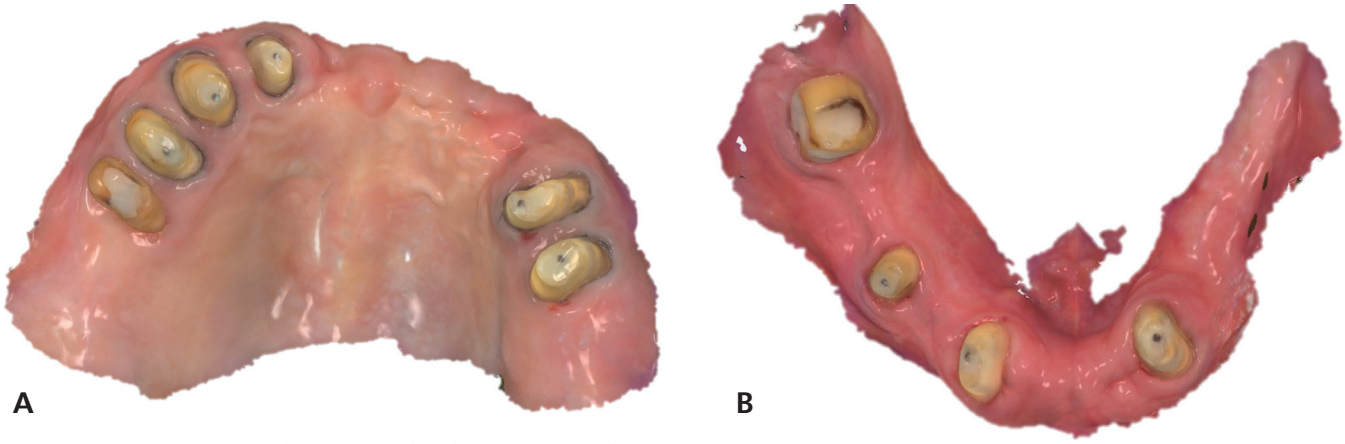


Figure 6. An intraoral scanner (3-shape Trios 3) captured the abutments and edentulous ridge morphology. (A) Upper arch. (B) Lower arch.

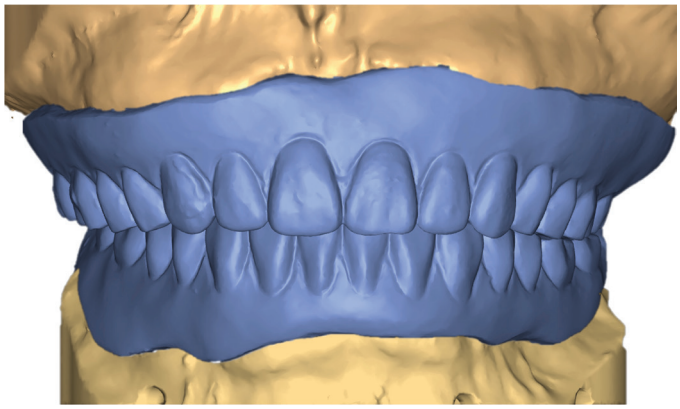


Figure 7.
Interim dentures were scanned with an extraoral scanner (3-shape E3) to record the vertical dimension and jaw relationship. The digital data of the interim denture and bimaxillary arch were superimposed in the Exocad software to display the patient's jaw relationship and design the definitive prostheses.

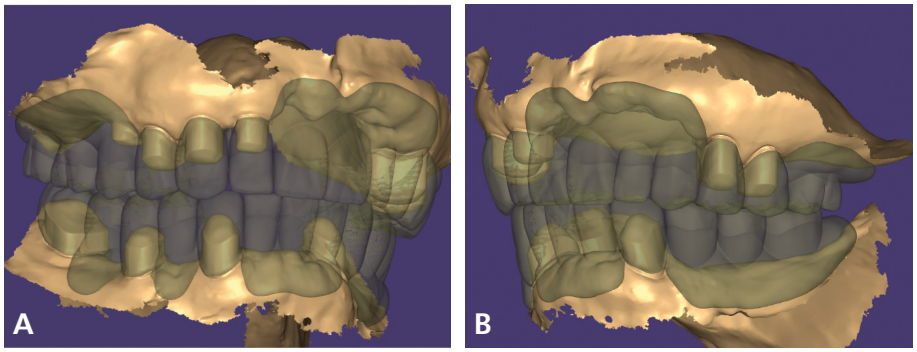


Figure 8. A digital wax-up of the upper and lower dentures was made to analyze inter- arch space and predict the future

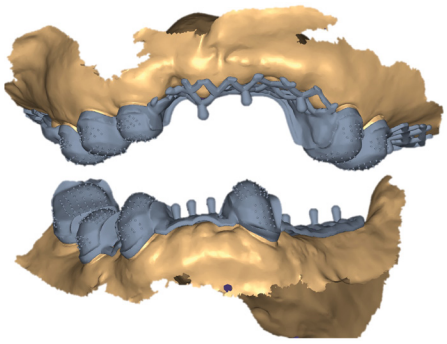


Figure 10. Digital design of the outer crowns and frameworks.

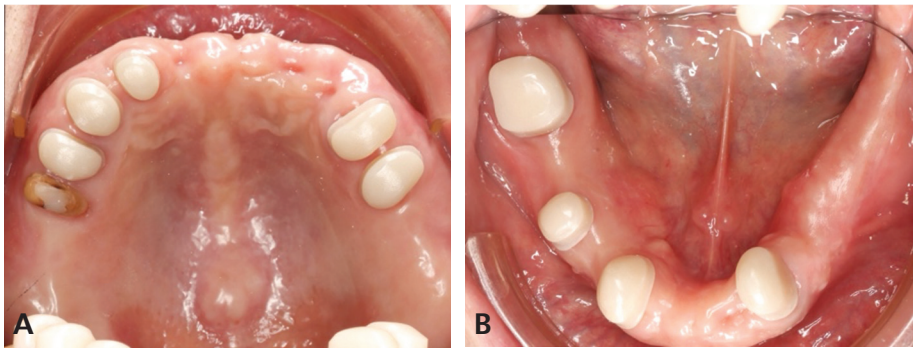


Figure 9. Clinical examination for the try-in step of zirconia inner crowns. (A) Occlusal view of the upper arch. (B) Occlusal view of the lower arch.

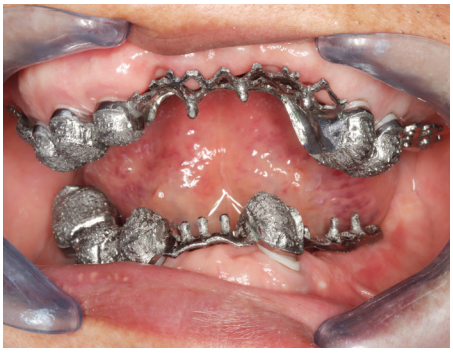


Figure 11.
Outer crowns and frameworks were fabricated from titanium by SLM. The images showed a good fit and stable structure at this try-in appointment.

※贋復學會版權所有禁止拷貝

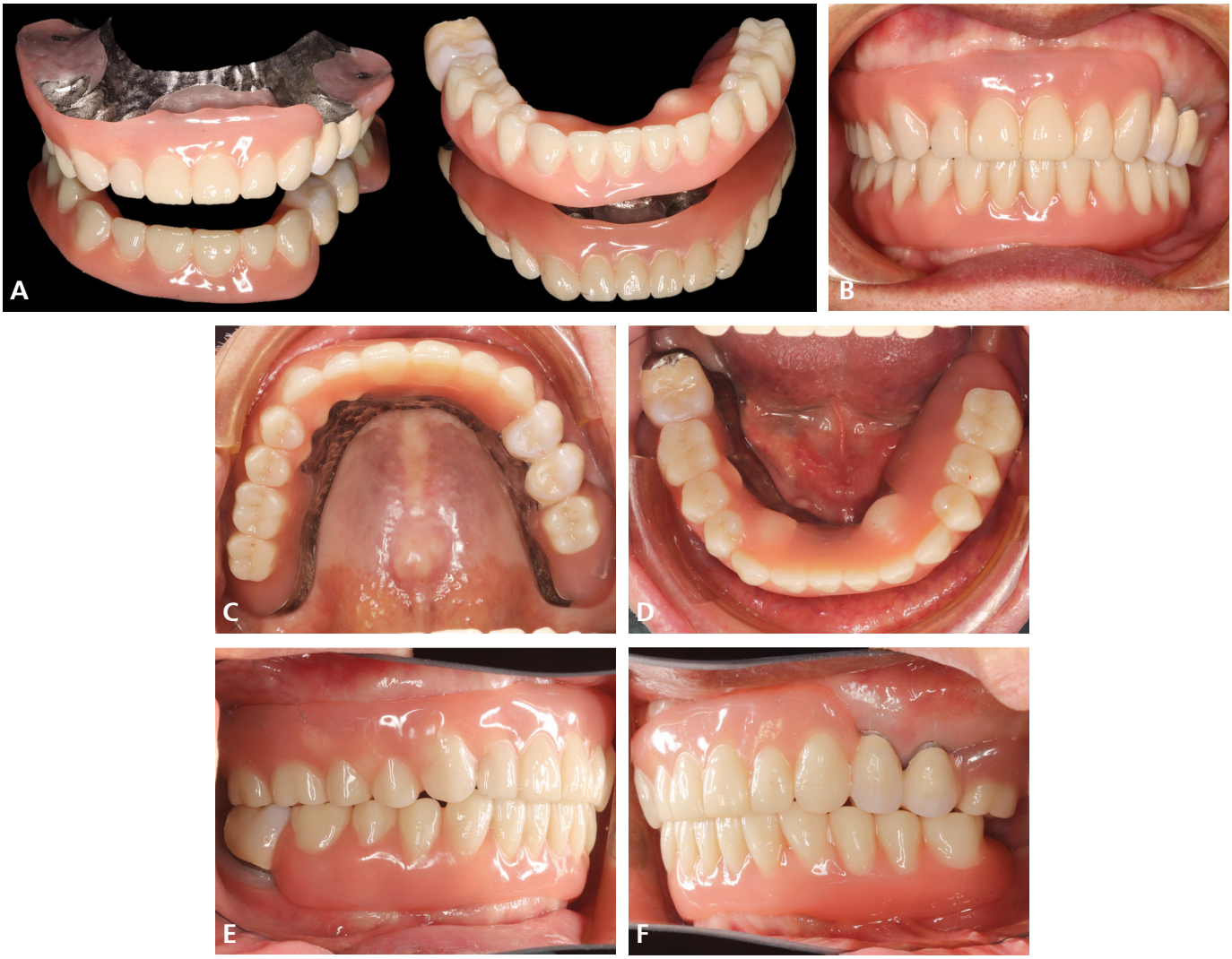


Figure 12. After the conventional packing procedure, the definitive dentures were fabricated and delivered for long-term use. (A) The upper and lower telescopic dentures after the packing and polish procedure. (B) Frontal view of the final prostheses. (C) Occlusal view of the upper denture. (D) Occlusal view of the lower denture. (E) Right side lateral view. (F) Left side lateral view.

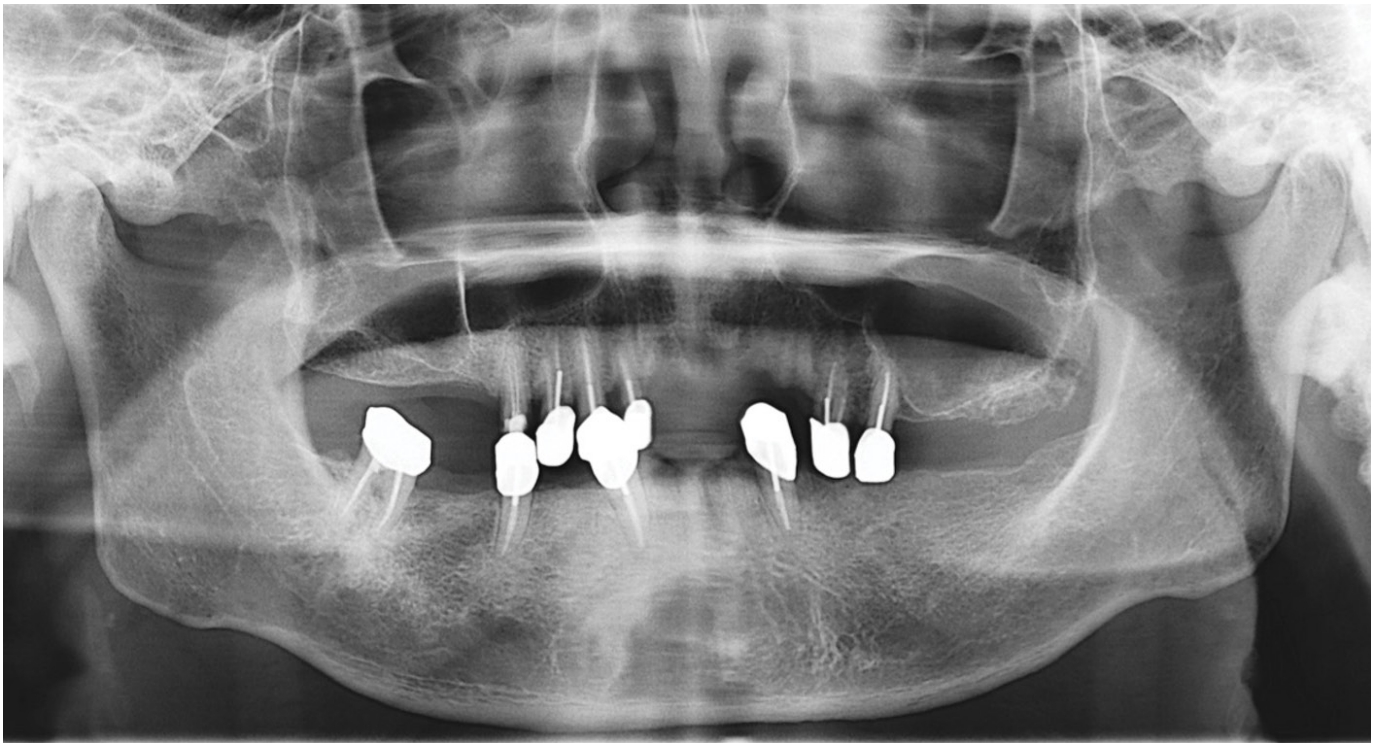


Figure 13. The panoramic radiograph film taken after three months of follow-up.

※贋復學會版權所有禁止拷貝

Discussion

Patients with poor occlusal support, such as missing adjacent teeth and the presence of opposing teeth, suffer from unequal bone resorption, leading to an uneven occlusal plane, bite collapse, periodontitis, and even an increased risk of tooth loss.[3, 4] A telescopic denture is defined as "an overdenture which is a dental prosthesis that covers and is partially supported by natural teeth, natural tooth roots, and/or dental implants." The term "double crowns" was first used by an American dentist over 100 years ago.[5] This treatment is indicated when a few unfavorably distributed abutment teeth remain within the arch.[6] It uses the existing abutment teeth as retainers, which consist of two crowns—the primary or inner crown, which is cemented to the abutment, and the secondary or outer crown, which is attached to the denture—where these additional attachments serve to increase the retention and stability of the prosthesis.[7, 8] With the double-crowns attachment system, clinicians can design a "clasp-free" denture to improve the esthetic demand. In summary, the benefits of telescopic overdentures include preventing bone loss,[9] enhanced esthetic appeal, improved speech (compared to other denture types), proper jaw alignment, and improved chewing efficiency.

Many double-crown systems have been reported in the literature. Retention of the telescopic denture relies heavily on the frictional surfaces between the double crowns. The inner crowns and secondary denture components should have high shear strength and wear resistance. The use of ceramics in dentistry and dental technology has increased in recent years. Among other materials, zirconia has been used to manufacture coping frameworks due to its good mechanical and biocompatible properties. Its use is supported by some studies that examined removable dentures retained on natural teeth or implants using zirconia as copings and/or implant abutments.[10, 11, 12] Almost no fractures of the zirconia copings were observed in this study. These copings or inner crowns proved a successful alternative to classic noble metal alloy copings, especially since the patient had high esthetic demands.

The SLM technique was recently developed to fabricate biomedical components from metals such as gold, cobalt-chromium, and titanium (e.g., Ti-6Al-4V) alloys.[13, 14, 15, 16] Titanium alloys are known for their attractive properties for dental restorations, including corrosion resistance, good mechanical properties, excellent biocompatibility to surrounding tissue, low allergenic potential, and low cost compared to noble metals. Titanium use in dental prostheses is relatively limited in the conventional method because of casting difficulties. Titanium alloys are easily oxidized at high temperatures and react with the investment material required for casting, eventually leading to shrinkage, rough surfaces, and internal defects in the framework.[17] The SLM fabrication method provides the multi-functional capabilities of layer manufacturing and the ability to build complex custom metal structures from any 3D CAD design, which takes advantage of conventional manufacturing processes.[18]

Many factors influence the retentive force of a telescope denture, including the width and height of the inner crown, axial taper angle, adaptability of the outer crown, and gap width in the occlusal region between the inner and outer crowns.[19, 20] Due to digital manufacturing, the axial taper angle and gap width required for outer crowns can be accurately printed using the SLM method. Double crowns made with different materials exhibit different retention forces because of the different friction coefficients between the contact surfaces of the inner and outer crowns.[21] Ideally, the telescopic dentures should be designed to retain stable retention without over- or under-retention. The minimum required retention is preferred to allow the patient to easily remove the denture while ensuring that the denture remains seated during physiologic activities. The over-retention of a telescopic denture can loosen the inner crown or abutments, cause trauma or fracturing of the root, or damage the denture. Therefore, telescopic dentures with more than five abutments are not recommended.[22] In our case, the retentive force between zirconia and the SLM titanium alloy was adequate for telescopic dentures with 4~5 abutments.

Several materials (and combinations of materials) have been used to make telescopic crowns, including precious and non-precious metal alloys, zirconia, and polyether ether ketone.2 The inner and outer crown will wear during long-term use in patients with good mastication function. The materials typically combined in telescopic dentures create a metal-metal, zirconia-metal, or metal-polymer contact, which has different surface

※贋復學會版權所有禁止拷貝

wear patterns and, therefore, variable resistance to repetitive removal-insertion cycles.21 A hard material with high resistance to wear is generally chosen for the inner crown and a more flexible material for the outer crown.[23]

Zirconia is often a modified yttria (Y_2O_3) tetragonal zirconia polycrystal, a relatively hard material used in dentistry. Zirconia and titanium alloy show different mechanical properties in compression tests.[24] While zirconia is harder than titanium alloy, their wearing interactions in telescopic dentures were unclear in recent studies. While zirconia is harder than enamel, highly polished zirconia is more wear-friendly to the opposing teeth than other materials.[25] Wearing between inner and outer crowns is inevitable in telescopic denture systems. Some clinical procedures can regain retention force. The wedge effect and retention force could be increased by creating an occlusal gap between the inner and outer crowns. Some reline material (Friktions Geschiebe Passung FGP; Brendent, Senden, Germany) could be applied to the inner surface of the outer crowns to increase friction and regain retention force.[26]

Recording the jaw relation is a fundamental and crucial step in providing a well-functioning restoration. Many devices can record the patient's inter-arch relationships. The occlusal vertical dimension can be registered digitally by scanning the bite record. In this case, the patient was adapting well to his interim dentures. After three months of function and adjustment, the vertical dimension and jaw relationship were very stable, and no parafunction was noted. The interim denture was scanned and duplicated as a bite record to accurately duplicate the jaw relationship. The upper and lower digital data could be precisely set in the design software by superimposing the intra-oral scanning models and bite records. Due to the precise jaw relationship and digital devices, the inner and outer crowns, framework, and artificial teeth could be well designed and fabricated in the following steps.

In this clinical report, multiple digital methods and materials were used for full mouth reconstruction. This digitally-assisted method provided a more efficient and precise way to fabricate telescopic overdentures.[27,28,29] During the 1.5 years of follow-up, the patient was comfortable and continued wearing the dentures, and his masticatory function and physical appearance were improved. However, further studies and research are worthwhile, and long-term follow-up should be considered.

Summary

This clinical report described the treatment procedure of a patient with poor occlusal support. Digitally-assisted methods and multiple materials were used in this case. The definitive prostheses were manufactured using digital scanning devices, CAD software, zirconia inner crowns, SLM titanium outer crowns and framework, PMMA artificial teeth, and conventional packing resin. More studies and follow-ups are needed.

Acknowledgments

This study was supported by the Southern Taiwan Science Park Precision Health Cluster of the National Science and Technology Council (funding ID: BX-02-10-14-111).

Conflict of Interest Statement

The authors declare no conflicts of interest related to this article.

※贋復學會版權所有禁止拷貝

References

1. Goswami R, Mahajan P, Siwach A, Gupta A. Telescopic overdenture: Perio-prostho concern for advanced periodontitis. Contemporary Clinical Dentistry 2013; 4: 402-5.
2. Hakkoum MA, Wazir G. Telescopic Denture. Open Dent J. 2018; 12:246-254.
3. Fushida, S., Kosaka, T., Kida, M., Kokubo, Y., Watanabe, M., Higashiyama, A., Miyamoto, Y., Ono, T., & Ikebe, K. (2021). Decrease in posterior occlusal support area can accelerate tooth loss: The Suita study. Journal of prosthodontic research 2021; 65, 321–6.
4. Sato, H., Hatta, K., Murotani, Y., Takahashi, T., Gondo, Y., Kamide, K., Masui, Y., Ishizaki, T., Kabayama, M., Ogata, S., Matsuda, K. I., Mihara, Y., Fukutake, M., Hagino, H., Higashi, K., Akema, S., Kitamura, M., Murakami, S., Maeda, Y., & Ikebe, K. Predictive factors for tooth loss in older adults vary according to occlusal support: A 6-year longitudinal survey from the SONIC study. Journal of dentistry 2022; 121, 104088.
5. Dexter JE .The cap plate: a new appliance in mechanical dentistry. D. Cosmos 1883; 25: 344–50.
6. Cho JH, Cho SA. The use of telescopic crowns in removable partial denture treatment for patients with severe periodontal disease: two patient case history reports. Int J Prosthodont 2016; 29: 175-8.
7. Bhagat TV, Walke AN. Telescopic partial dentures - concealed technology. J Int Oral Health 2015; 7: 143-7.
8. Gada S, Nallaswamy D, Jain AR. Full mouth rehabilitation of periodontally compromised partially edentulous arches with multiple missing teeth using telescopic crown and bridge - a case report. Drug Invent Today 2018; 10: 1999-2003.
9. Crum RJ, Rooney Jr GE. Alveolar bone loss in overdentures: a 5-year study. The Journal of prosthetic dentistry 1978; 40: 610-3.
10. Ro¨sch R, Mericske-Stern R. Zirconia and removable partial dentures. Schweiz Monatsschr Zahnmed 2008; 118: 959–74
11. Bae KH, Han JS, Seol YJ, Butz F, Caton J, Rhyu IC. The biologic stability of alumina-zirconia implant abutments after 1 year of clinical service: a digital subtraction radiographic evaluation. Int J Periodontics Restorative Dent 2008; 28: 137–43.
12. Uludag B, Sahin V, Ozturk O. Fabrication of zirconium primary copings to provide retention for a mandibular telescopic overdenture: a clinical report. Int J Prosthodont. 2008; 21: 509–10
13. Khan M, Dickens P. Selective Laser Melting (SLM) of Pure Gold for Manufacturing Dental Crowns. Rapid Prototyping Journal 2014; 20:471-9.
14. Santos CD. CoCr Mo-base Alloys for Dental Applications Obtained by Selective laser melting (SLM) and CAD/CAM Milling. Materials Research 2020; 23
15. Harada Y, Ishida Y, Miura D, Watanabe S, Aoki H, Miyasaka T, Shinya A. Mechanical Properties of Selective Laser Sintering Pure Titanium and Ti-6Al-4V, and Its Anisotropy. Materials 2020; 13: 5081.
16. Antanasova M, Kocjan A, Abram A, Kova J, Jevnikar P. Pre-oxidation of selective-laser-melted titanium dental alloy: effects on surface characteristics and porcelain bonding. Journal of Adhesion Science and Technology 2021; 35:19, 2094-109
17. Wang RR, Fenton A. Titanium for prosthodontics application: a review of the literature. Quintessence Int 1996; 27:401-8.
18. Munir, Khurram. Selective laser melting in biomedical manufacturing. Metallic Biomaterials Processing and Medical Device Manufacturing.2020, 235-69.
19. Körber KH. Konuskronen. Das rationelle teleskopsystem einfuhrung in klinik und technik, A Hüthig Verlag GmbH, Heidelberg, 1983; 76-90.
20. Shimakura M, Nagata T, Takeuchi M, Nemoto T. Retentive force of pure titanium konus telescope crowns fabricated using CAD/CAM system. Dent Mater J. 2008; 27:211-5.
21. Arnold C, Hey J, Setz JM, Boeckler AF, Schweyen R. Retention force of removable partial dentures with different double crowns. Clinical Oral Investigations 2018; 22:1641-9.
22. Goto T, Kuroda H. Rigid support and konuskrone. Practice Prosthodont 1996;29:7–50.
23. Schimmel M, Walther M, Al-Haj Husain N, Igarashi K, Wittneben J, Abou-Ayash S. Retention forces between primary and secondary CAD/CAM manufactured telescopic crowns: an in vitro comparison of common material combinations. Clin Oral Investig. 2021;25:6297-307.
24. Chun KJ, Lee JY. Comparative study of mechanical properties of dental restorative materials and dental hard tissues in compressive loads. J Dent Biomech. 2014;11:5
25. Janyavula, Sridhar; Lawson, Nathaniel; Cakir, Deniz; Beck, Preston; Ramp, Lance C.; Burgess, John O. The wear of polished and glazed zirconia against enamel. The Journal of Prosthetic Dentistry, 2013; 109, 22–9
26. Bortun, M. FGP Friction Fit System used in Telescopic Technique of Removable Partial Dentures. Materiale plastice, 2014, 5: 440-3.
27. Fueki K, Inamochi Y, Wada J. A systematic review of digital removable partial dentures. Part I: Clinical evidence, digital impression, and maxillomandibular relationship record. J Prosthodont Res. 2022;66:40-52.
28. Carneiro Pereira AL, Bezerra de Medeiros AK, de Sousa Santos K, Oliveira de Almeida É, Seabra Barbosa GA, da Fonte Porto Carreiro A. Accuracy of CAD-CAM systems for removable partial denture framework fabrication: A systematic review. J Prosthet Dent. 2021;125:241-8.
29. Nishiyama H, Taniguchi A, Tanaka S, Baba K. Novel fully digital workflow for removable partial denture fabrication. J Prosthodont Res. 2020;64:98-103.

※贋復學會版權所有禁止拷貝

※贋復學會版權所有禁止拷貝

Introduction for authors

Types of article

All works related to basic or clinical prosthodontics, temporomandibular joints or masticatory function, dental implants, and technical science of dental prosthodontics are the objects of publication. There are five types of accepted manuscripts, please indicate the type of manuscript.

- Review article
- Original article
- Technical report
- Case report
- Letters to the Editor

General Format guide

- Articles must not have been published or will be accepted for publication in other journals.
- Please write your text in good English (American or British usage is accepted, but not a mixture of these) , and the content of the article is typed in double spacing, with font size 12 and above, with at least 2.5 cm margin on each side, and without any formatting.
- The total number of pages of the full text (including abstract, figures, tables, and references) is limited to eight pages, and can be extended to twelve pages if necessary.
- Please use electronic documents to submit manuscripts. IBM-Microsoft Word is recommended as the word processing program. The program used, the title of the manuscript, and the name of the first author must be marked. The electronic file should be emailed to: prosthor@ms48.hinet.net.
- Please also include a short letter to the Editor-in-Chief of the Journal stating that you would like to contribute to the Journal and stating that all authors have read and signed the consent form. If the research involves the use of human subjects, the manuscript must be accompanied by the consent of the appropriate institutional review board or ethics committee.

Review Articles Format Guide

These should aim to provide the reader with a balanced overview of an important and topical issue in prosthodontic field. They should cover aspects of a topic in which scientific consensus exists as well as aspects that remain controversial and are the subject of ongoing scientific research. All articles or data sources should be selected systematically for inclusion in the review and critically evaluated.

- Abstract: required, up to 400 words, unstructured (i.e., no subheadings)
- Keywords: up to 10
- Word limit: 3500 words
- References: up to 100
- Tables/Figures: 1 maximum

Original Articles Format Guide

Section headings should be: Abstract, Introduction, Materials and methods, Results, Discussion, Conclusion Conflicts of Interest Statement, Acknowledgments (if any), and References.

(1) ***The Introduction*** should provide a brief background to the subject of the paper, explain the importance of the study, and state a precise study question or purpose.

(2) ***The Materials and methods*** section should describe the study design and methods (including the study setting and dates, patients/participants with inclusion and exclusion criteria, patient samples or animal specimens used, the essential features of any interventions, the main outcome measures, the laboratory methods followed, or data sources and how these were selected for the study), and state the statistical procedures employed in the research.

(3) ***The Results*** section should comprise the study results presented in a logical sequence, supplemented by tables and/or figures. Take care that the text does not repeat data that are presented in tables and/or figures. Only emphasize and summarize the essential features of the main outcome measures, and the main results.

(4) ***The Discussion*** section should be used to emphasize the new and important aspects of the study, placing the results in context with published literature, the implications of the findings.

(5) The conclusion that follows from the study results.

- Abstract: required, up to 400 words
- Keywords: up to 10
- Word limit: 3000 words
- References: up to 40

※贋復學會版權所有禁止拷貝

Technique Reports/ Case Reports Format Guide

These are short discussions of a case / case series/ technique report with unique features not previously described that make an important teaching point or scientific observation. They may describe novel techniques or use of equipment, or new information on diseases of importance. Section headings should be: Abstract, Introduction, Case Report, Discussion, Conflicts of Interest Statement (if any), Acknowledgments (if any), and References.

Case reports should have no more than 6 authors. The maximum length is 2000 words, and the number of references should not exceed 10.

Letters to the Editor Format Guide

Brief letters of constructive comments in response to previously published JDS articles are welcome. Ensure that the corresponding author's mailing and e-mail addresses are included. Letters are edited, sometimes extensively, to sharpen their focus. They may be sent for peer review at the discretion of JDS Editors. Letters are selected based on clarity, significance, and space.

- Author: up to 3
- Word limit: 250 words
- Tables/Figures: 1 maximum

Manuscript Preparation

Text should be typed double-spaced on one side of white A4 (297 × 210 mm) paper, with outer margins of 2.5 cm. A manuscript should include a title page, abstract, text, references, conflicts of interest statement (if any), acknowledgments (if any), and figures and tables as appropriate. Each section of the manuscript should begin on a new page. Pages should be numbered consecutively, beginning with the title page.

The detailed specifications of the manuscript content are as follows:

➢ ***Title page***

The title page should contain the following information (in order, from the top to bottom of the page): article category article title names (spelled out in full) of all authors*, and the institutions with which they are affiliated†; indicate all affiliations with a superscripted lowercase letter after the author's name and in front of the matching affiliation corresponding author details (name, e-mail, mailing address, telephone and fax numbers). A running title must be within 40 characters. Please provide the detailed information of the corresponding author (name and address in English, telephone and fax numbers, email address).

➢ ***Abstract and keywords***

An abstract (no longer than 400 words) and relevant keywords (limited to 5) are required.

(1) Abstracts for **Review Articles, Case Reports and Technique report** should be *unstructured (in one single paragraph with no section headings)*, and include information on the background/purpose of the report, methods, results (or case report), and conclusions.

(2) Abstracts for **Original Articles** should be structured into the following sections. **Aims:** briefly explain the importance of the study topic and state a precise study question or purpose. **Materials and Methods:** briefly introduce the methods used to perform the study; include information on the study design, setting, subjects, interventions, outcome measures and analyses as appropriate. **Results:** briefly present the significant results, with data and statistical details such as p values where appropriate; be sure that information in the abstract matches that in the main text. **Conclusion:** state the meaning of your findings, being careful to address the study question directly and to confine your conclusions to aspects covered in the abstract; give equal emphasis to positive and negative findings.

(3) Keywords should be taken from the Medical Subject Headings (MeSH) list of Index Medicus (http://www.nlm.nih.gov/mesh/meshhome.html).

➢ ***Main Text***

(1) **Review article:** Review articles should be unstructured (no fixed format).

(2) **Original article:** The text for original articles should be organized into the following sections: introduction, materials and methods, results, discussion, and conclusion.

- Introduction: Briefly explain the origin of the research.
- Materials and methods: Describe the research design, objects, and procedures.
- Results: The results are expressed in words, tables or illustrations.
- Discussion: Emphasize important results and arguments, and compare with previous studies.
- Conclusion: The conclusion should be concise and clear.
- Conflicts of interest statement
- Acknowledgments (if any)
- References

※贋復學會版權所有禁止拷貝

(3) **Technical report**

Sections for technical reports are Introduction, Methods, and Discussion, Conflicts of interest statement (if any), Acknowledgments (if any), and References. Each section should begin on a new page.

(4) **Case report**

Sections for case reports are Introduction, Case description, and Discussion, Conflicts of interest statement (if any), Acknowledgments (if any), and References. Each section should begin on a new page.

(5) **Abbreviations**

Where a term/definition will be continually referred to, it must be written in full when it first appears in the text, followed by the subsequent abbreviation in parentheses. Thereafter, the abbreviation may be used. An abbreviation should not be first defined in any section heading; if an abbreviation has previously been defined in the text, then the abbreviation may be used in a subsequent section heading. Restrict the number of abbreviations to those that are absolutely necessary and ensure consistency of abbreviations throughout the article. Ensure that an abbreviation so defined does actually appear later in the text (excluding in figures/tables), otherwise, it should be deleted.

(6) **Numbers**

Numbers that begin a sentence or those that are less than 10 should be spelled out using letters. Centuries and decades should be spelled out, e.g., the Eighties or nineteenth century. Laboratory parameters, time, temperature, length, area, mass, and volume should be expressed using digits.

(7) **Units**

Système International (SI) units must be used, with the exception of blood pressure values which are to be reported in mmHg. Please use the metric system for the expression of length, area, mass, and volume. Temperatures are to be given in degrees Celsius.

(8) **Names of drugs, devices and other products**

Use the Recommended International Nonproprietary Name (rINN) for medicinal substances, unless the specific trade name of a drug is directly relevant to the discussion. Generic drug names should appear in lowercase letters in the text. If a specific proprietary drug needs to be identified, the brand name may appear only once in the manuscript in parentheses following the generic name the first time the drug is mentioned in the text.

For devices and other products, the specific brand or trade name, the manufacturer and their location (city, state, country) should be provided the first time the device or product is mentioned in the text, for example, “”¡KSPSS version 11 was used (SPSS Inc., Chicago, IL, USA)””. Thereafter, the generic term (if appropriate) should be used.

➢ ***References***

References should be limited to those cited in the text and listed in numerical order (superscript). Please refer to Cumulated Index Medicus for the writing format. References should include, in order, all authors’ names, article title, journal name, year, volume and inclusive page numbers.

Authors are responsible for the accuracy and completeness of their references and for correct in- text citation. If massive corrections to the references are found to be necessary in the event that your manuscript is accepted, JPI Editors reserve the right to rescind the accept decision and reject the article.

References should include, in order, authors’ surnames and initials, article title, abbreviated journal name, year, volume and inclusive page numbers. The surnames and initials of all the authors up to 6 should be included, but when authors number 7 or more, list the first 3 authors only followed by “et al”.

Examples of the common reference types are provided below.

- **Standard journal articles:** Lin YT, Chang LC. Space changes after premature loss of the mandibular primary first molar: a longitudinal study. J Clin Pediatr Dent 1998; 22:311-6.
- **Book with edition:** McDonald RE, Avery DR. Dentistry for child and adolescent. 6th ed., Mosby Co., St. Louis, 1994; pp339-41.
- **Book chapter in book with editor and edition:** Moore BK, Avery DR. Dental materials. In: McDonald RE, Avery DR. Dentistry for child and adolescent. 6th ed., Mosby Co., St. Louis, 1994; pp349-72.
- **Electronic publications:** Yavuz MS, Aras MH, üyükkurt MC, Tozoglu S. Impacted mandibular canines. J Contemp Dent Pract 2007;8(7):78- 85. Available at: http://www.thejedp.com/issue036/index.htm. Accessed November 20, 2007.

※贋復學會版權所有禁止拷貝

➢ ***Figures and legends***

- Illustrations should not be included in the main text or edited, but should be stored in a separate folder. Image files should be archived in JPG, EPS or TIF format and submitted electronically via e-mail.
- The title and detailed description of the illustration must be typed double-spaced on a separate page. Photomicrographs should include an internal scale marker to indicate the magnification.
- The patient's facial photo must cover the eyes to the extent that the person cannot be identified, otherwise the patient's written consent must be attached.
- Drawing software such as Photoshop, Photoimpact, Illustrator, etc. should be used. Color or grayscale graphics must be scanned at 300 DPI, and line graphics must be scanned at 1200 DPI. Please indicate the name of the image file and the name of the software and hardware used.
- The number of figures should be restricted to the minimum necessary to support the textual material. Figures should have an informative figure legend and be numbered in the order of their citation in the text.
- All symbols and abbreviations should be defined in the figure legend in alphabetical order.

➢ ***Tables***

The title and detailed description of each table must be typed double-spaced on separate pages, and numbered in Arabic numerals.

Tables should supplement, not duplicate, the text. They should have a concise table heading, be self-explanatory, and numbered consecutively in the order of their citation in the text. Items requiring explanatory footnotes should be denoted using superscripted lowercase letters (a, b, c, etc.), with the footnotes arranged under the table in alphabetical order. Asterisks (*, **) are used only to indicate the probability level of tests of significance. Abbreviations used in the table must be defined and placed after the footnotes in alphabetical order. If you include a block of data or table from another source, whether published or unpublished, you must acknowledge the original source.

➢ ***Acknowledgments***

After the Conflicts of Interest Statement and/or Funding/Support Statement, general acknowledgments for consultations and statistical analyses should be listed concisely, including the names of the individuals who were directly involved. Consent should be obtained from those individuals before their names are listed in this section. Those acknowledged should not include secretarial, clerical or technical staff whose participation was limited to the performance of their normal duties.

Submission List

- A short letter to the Editor-in-Chief.
- The detailed information of the corresponding author (name and address in Chinese and English, telephone and fax numbers, email address). The names of all authors and their affiliations.
- An abstract in English (no longer than 400 words) containing the study purpose, materials and methods, results, and main conclusion.
- Keywords (limited to 5) and a running title within 40 characters.
- Confirm that the format, content, and order of citation of all references are complete and correct.
- Confirm titles and footnotes for all tables, and detailed titles and descriptions for figures. Type them double-spaced on separate pages.
- Verify that all tables and figures are formatted correctly. Tables and figures are stored in separate folders and not included in the main text.
- If the research involves human subjects, the consent from the institutional review board or ethics committee must be attached.
- Letter of consent signed by all authors.

After acceptance

Benefits to authors

- Once the manuscript is published, the copyright belongs to this Journal. All articles in this Journal have been uploaded to DOI, and no free copies are provided for the first author or corresponding author.
- We also provide many author benefits, such as free PDFs, a liberal copyright policy.

※贋復學會版權所有禁止拷貝

投 稿 須 知

一、凡與基礎或臨床補綴學、顳顎關節或咀嚼功能、人工植體相關、牙科補綴之技工學有關之著作，均為刊載之對象。接受的稿件類型共有下列五種，來稿請註明類型：

1. 學術綜論（review article）
2. 研究論文（original artic1e）
3. 技術報告（technical report）
4. 病例報告（case report）
5. 給編輯的信（Letter to editorial）

二、稿件撰寫一般格式：

1. 文章必須是沒有刊於或將被接受刊於其他雜誌。
2. 英文投稿，文章內容以複行（double spacing）繕打，字體大小12 以上，其每邊邊緣至少須留 2.5 公分，不須任何格式編排。
3. 全文總頁數（包括摘要、圖、表、參考文獻）以八頁為限，必要時可增至十二頁。
4. 請以電子文件投稿，文書處理程式建議以IBM-Microsoft Word為主。
5. 須標示使用程式、投稿題目、第一作者姓名，將電子文件E-mail至：prosthor@ms48.hinet.net。
6. 請同時附上致本誌主編簡短信函，表明投稿本誌之意願，並說明所有著者均曾過目並簽名同意。若為人體試驗須附人體試驗委員會之同意函。

三、稿件內容詳細規格如下：(詳細撰寫格式，請參閱JPI 英文指引)

1. 首頁（title page）：包括題目、作者姓名、服務單位、學歷；英文簡題（running title）長度在四十個字以內；稿件主要負責者（corresponding author）之英文姓名與地址、電話、傳真、e-mail。
2. 英文摘要（abstract）：以 400 字為限，簡潔說明研究目的、方法、結果、主要結論或新發現。並需附關鍵詞（key words）5 個以內。
3. 本文（text）：
   (1) 學術綜論（review article）ㄧ無一定格式。
   (2) 原始著作（original article）ㄧ分前言、材料與方法、結果、討論、結論。
   - 前言（introduction）：簡要說明研究由來。
   - 材料與方法（material and methods）：敘述研究設計、對象、步驟。
   - 結果（results）：研究結果以文字、表格或插圖表示之。
   - 討論（discussion）：強調重要結果與論點，與前人論述作比較等。
   - 結論（conclusion）：結論要簡要明確。

   (3) 技術報告（technical report）ㄧ分前言、方法、討論。
   (4) 病例報告（case report）ㄧ分前言、病例、討論。

※贋復學會版權所有禁止拷貝

4. 參考文獻（references）：以出現於本文中之先後順序用阿拉伯數字（上標）排列之，書寫方式請參考Cumulated Index Medicus，內容含作者姓名（全部列出）、篇名、期刊名、年代、頁數。

   例如：

   (1) 期刊之書寫：

   Lin YT, Chang LC. Space changes after premature loss of the mandibular primary first molar: a longitudinal study. J Clin Pediatr Dent 1998; 22: 311-6.

   (2) 書籍之書寫：

   McDonald RE, Avery DR. Dentistry for child and adolescent 6th ed., Mosby Co, St Louis, 1994; pp339-41.

   (3) 有編輯者之書籍章節書寫：

   Moore BK, Avery DR. Dental materials. In: McDonald RE, Avery DR. Dentistry for child and adolescent 6th ed., Mosby Co., St. Louis, 1994; pp349-72.

   (4) 電子期刊之書寫：

   Yavuz MS, Aras MH, üyükkurt MC, Tozoglu S. Impacted mandibular canines. J Contemp Dent Pract 2007; 8(7):78-85. Available at: http://www.thejedp.com/issue036/index.htm. Accessed November 20, 2007.

5. 插圖與說明（figures and legends）：

   (1) 插圖請勿放置於本文中，也不要編排，應儲存於另外的檔案夾。影像圖檔應以 JPG、EPS 或 TIF 格式存檔。插圖以電子檔 e-mail 傳送投稿。

   (2) 插圖之標題及詳細說明，須另頁複行繕打。顯微照像須以比例尺（internal scale marker）標明放大倍數。

   (3) 病人臉部照片須遮蓋眼睛至無法辨認是何人的程度，否則須附病人之書面同意書。

   (4) 繪圖軟體應使用如 Photoshop、Photompact、Illustrator 等。彩色或灰階圖形須掃瞄至 300 DPI，線條圖形則須至 1200 DPI，並請標明圖檔名稱及所使用軟硬體名稱。

6. 表格（tables）：每一表格應為單獨一頁，須有標題及詳細說明，複行繕打，並冠以阿拉伯數字順序。

四、投稿清單

- 致主編簡短信函。
- 提供稿件主要負責者之姓名與地址（中英文）、電話、傳真、e-mail、所有作者之服務機構（英文）。
- 附英文摘要（400 字以內），研究論文的摘要應分研究目的、方法、結果、主要結論。
- 附英文關鍵詞（5 個以內）；附英文簡題（長度在 40 個字以內）。
- 確認所有參考文獻的格式、內文、引用順序皆完整無誤。
- 確認所有表格（標題、註腳）及插圖之標題及詳細說明，另紙複行繕打。
- 確認所有圖表皆符合格式。圖表皆儲存於另外的檔案夾，而未放置於本文中。
- 若為人體試驗須附人體試驗委員會之同意函。
- 全部作者同意簽名之證明函。

五、稿件一經刊載，版權屬本誌所有；本誌文章皆已上載至DOI，將不另行提供抽印本。

※贋復學會版權所有禁止拷貝

Table of Contents

ISSN 2304-541-8

9 772304 541008

※贋復學會版權所有禁止拷貝