http://dx.doi.org/10.4047/jkap.2015.53.4.337

지대치 삭제의 정확도가 레이져 신터링 기술로 제작된 Co-Cr 코핑의 변연적합도에 미치는 영향

김서랑 · 곽재영* · 허성주 · 김성균 · 김명주
서울대학교 치과대학 치과보철학교실

Influence of the accuracy of abutment tooth preparation on the marginal adaptation of Co-Cr alloy copings fabricated with a selective laser sintering technology

Seo-Rahng Kim, Jai-Young Koak*, Seong-Joo Heo, Seong-Kyun Kim, Myung-Joo Kim
Department of Prosthodontics, School of Dentistry, Seoul National University, Seoul, Republic of Korea

Purpose: The purpose of present study is to examine the correlation between the accuracy of abutment preparation and the marginal adaptation of metal coping. With this view, this study compared the correlations regard to the three different manufacturing methods of selective laser sintering technique, milling and casting. **Materials and methods:** Two master models were made in a different way. First model with deep chamfer margin was prepared directly by a general clinician and the second model was designed by 3-D designing software program with the same abutment preparation principle and produced by computer aided manufacturing. 12 Co-Cr alloy copings were produced respectively with three different method; SLS system, CAD/CAM milling and conventional lost wax technique from each master model. The total 72 copings fully sit on the master model were stereoscopically evaluated at 40 points along the entire circumferential margin. **Results:** Significant differences in the absolute marginal discrepancies of Co-Cr copings from SLS system (P=.0231) and casting method (P<.0001) were shown between hand preparation model and computer designed model. However, no significant difference was found between the two model groups from milling method (P=.9962). **Conclusion:** Within the limitation of this study, the effect of the accuracy of abutment preparation on the marginal adaptation of Co-Cr coping is statistically significant in SLS system and casting group. The copings produced by SLS system exhibited the lowest marginal discrepancies among all groups, and the marginal gap of this method group was influenced by the accuracy of the abutment preparation. *(J Korean Acad Prosthodont 2015;53:337-44)*

Key words: Tooth preparation; Marginal adaptation; Dental abutment; Confocal laser scanning microscope; Dental CAD/CAM

Introduction

Cobalt-Chrome alloy has been used commonly as a substructure for metal-ceramic restorations, as the material is rigid enough for the intraoral functioning, resistant to corrosion, more economic than noble alloys and causes less allergies than Nickel-Chrome alloy.[1-3] However, its high melting range, low ductility[4,5] and potential for oxidation of the base metals[6,7] make the casting process difficult and time consuming.

The traditional lost wax - casting method is still mostly used in fabricating metal coping, but some other techniques are applied to the manufacturing process nowadays with development of digital dentistry. Dental computer-aided design/computer-assisted manufacturing (CAD/CAM) systems has been developed a lot for recent

*Corresponding Author: Jai-Young Koak
Department of Prosthodontics, School of Dentistry, Seoul National University, 101, Daehak-ro, Jongno-gu, Seoul 03080, Republic of Korea
+82 2 2072 3027: e-mail, young21c@snu.ac.kr
Article history: Received July 30, 2015 / Last Revision September 21, 2015 / Accepted October 1, 2015

decades.[8] It is a subtractive method of milling block-shaped materials with diamond rotary instruments. The advantage of this method is time saving because multiple producing is possible at the same time and it simplifies many steps of conventional procedure,[9] whereas the waste of materials and the wear of milling burs can be its disadvantages.

In comparison with the milling method, selective laser sintering (SLS) is recently introduced as a manufacturing technology in dentistry. SLS is one of the rapid prototyping production methods, which fuses metal powder on to a solid part by melting it selectively using the focused laser beam and adds up layer by layer based on the CAD data.[5] This new technology, which is contrast to the milling technique in that it is an additive method, has no limitation of designing various three dimentional shapes and high speed of manufacturing.[10] However, this method is not popular owing to the expensive cost of the apparatus yet and the application of various dental materials is needed.

Some studies about the clinical acceptability of SLS technique have been conducted so far. Among the requirements for the success of the fixed prosthodontics, good marginal fit is very important factor for the prevention of recurrent caries and periodontal disease[11] and the longevity of the restorations.[12-14] Quante *et al*.[15] reported that no statistically significant differences between base metal alloy and precious alloy according to the marginal and internal fit of copings produced with laser melting technology was found. Kim *et al*.[16] concluded that no significant difference was found between the measurements of marginal fit of three-unit fixed dental prostheses fabricated using a direct metal laser sintering system and that of three-unit prostheses by a conventional lost wax technique method. They also showed in another study that the gap of the metal cores produced by SLS increased after completion of porcelain firing on the metal core, but the gap was still acceptable clinically.[17] Meanwhile, Sundar *et al.*,[18] Bhaskaran*et al.*,[19] Oyagüe *et al.*[20,21] reported the best marginal fit than other manufacturing methods. Most of above studies concluded that SLS Co-Cr may be a reliable alternative to the casting of base metal alloys to obtain well-fitted crowns.[15-21] However, they all used the hand preparation abutment only or the master model with the extremely simplified cylinder shape. The purpose of this study was to evaluate the capacity of the SLS method to reflect the quality of abutment preparation into the marginal fit of the prosthesis. The null hypothesis of this present study was that the accuracy of abutment preparation do not influence the absolute marginal discrepancy of Co-Cr coping fabricated with SLS technology.

Materials and Methods

Fabrication of master models

Two master models with the different qualities of preparation were produced to simulate the complete crown preparation of the mandibular right first molar. One master model was produced from the standardized resin tooth with the average size and hardness of human tooth (A5AN-500, NISSIN DENTAL PRODUCTS INC., Kyoto, Japan). A general dental practitioner prepared the resin tooth with the followed principle: 1.0 - 1.5 mm of the occlusal reduction, deep chamfer margin with axiogingival internal line angle of 1.2 mm radius and 6 degrees of the convergent angle of axial wall (Fig. 1). The other model implemented the same principle as above completely by computer program (3D CAD, Dassault Syste ̀mes SOLIDWORKS Corp., Waltham, MA, USA) (Fig. 2). The design was represented on the titanium model by CAD/CAM.

Fig. 1. Resin tooth master model with hand perparation (1.2 mm deep chamfer margin preparation was made on a mandibular right first molar).

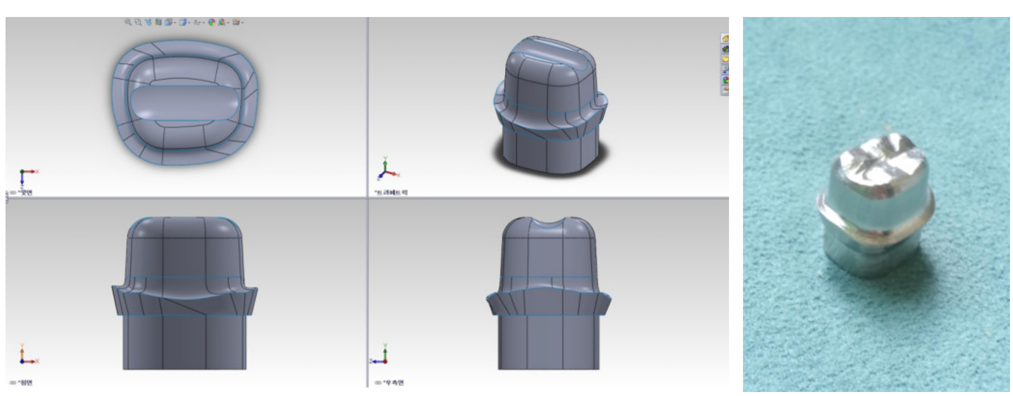

Fig. 2. The design of CAD model and titanium master model.

Fabrication of Co-Cr copings

Co-Cr copings for each model were fabricated with three different methods (Fig. 3A, Fig. 3B): (1) SLS, (2) milling method, and (3) conventional casting method. As each group had 12 samples, 72 samples were made in total.

(1) SLS: Each model was scanned by dental laser scanner (D-700, 3Shape, Copenhagen, Denmark). A skilled dental technician designed the coping using CAD software (3shape Dental Designer, 3Shape, Copenhagen, Denmark). The thickness of coping was designed to be 0.5 mm (the thinnest part has 0.4 mm), and the cement space was set at 35 ㎛ (the thinnest part has 25 ㎛) from 1mm above the margin. This CAD data was transferred to a laser sintering machine (EOSINT M270, EOS GmbH Electro Optical Systems, Krailling, Germany) for fabricating metal frameworks. The laser sintering procedure followed the recommendation of manufacturer (EOS GmbH Electro Optical System, Krailling, Germany) and used cobalt chromium alloy powder (Co 63.8, Cr 24.7, Mo 5.1, W 5.4, Si 1.0 ; EOS Cobalt Chrome SP2, EOS, Krailling, Germany). The fabrication was under the fixed condition ; a laser power of 200W, scan spacing of 0.1 - 0.2 mm, a laser scan speed of 7.0 m/sec and a layer thickness of 20 - 30 ㎛. 12 Co-Cr copings from the hand preparation model (HS) and 12 Co-Cr copings from the computer aided designed model (DS) were made respectively.

(2) Milling method: The same 3D CAD data as described above was sent to a milling center for computerized milling (PMS5 II, Dental Plus Co. Ltd, Kyeonggi, Korea) with Co-Cr alloy blocks (Co 62, Cr 30, Mo 6, Si, Mn, Fe, C ; CHROME-COBALT 95H10, Zirkonzahn, South Tyrol, Austria). 12 Co-Cr copings milled from the hand preparation model (HM) and 12 Co-Cr copings milled from the computer aided designed model (DM) were made in each group.

(3) Conventional lost-wax technique (CLWT): To obtain the exactly same wax pattern with copings made by SLS system, the same parameters in the 3D CAD data were sent to a milling center for computerized milling (Milling Unit M5 HEAVY, Zirkonzahn, South Tyrol, Austria) of wax (easymill Wax, High Dental Korea, Gwangju, Korea). The wax patterns were under the procedure of conventional lost-wax technique. 12 Co-Cr copings casted from the hand preparation model (HC) and 12 Co-Cr copings casted from the computer aided designed model (DC) were made in each group.

Measurements of the specimens

Measurement area of 3000 ㎛ were determined on each side and marked on the margin of the model. Each area has 10 reference points of P1 - P10 which have 300 ㎛ distance between adjacent points. Mesial, buccal, distal and lingual site of the master model have their measurement areas respectively (Fig. 4). The shortest distance from a reference point to the margin of the coping was measured and the average of 10 measurements represents the absolute marginal gap of the site.

Each specimen was measured at 40 reference points and 2880 measurements were performed on the 72 specimens in total. All copings were adjusted fully and fixed on the original master models with sticky wax (Model Cement; Dentsply DeTrey, Konstanz, Germany) for measuring of absolute marginal discrepancy. Specimens were mounted onto the confocal laser scanning microscope (CLSM) (LSM 5 PASCAL, Carl Zeiss MicroImaging GmbH, Goschwitzer, Germany) so that the laser beams were perpendicular to the objected two points and the distance between the points was calibrated by one experienced engineer according to the manufacturers instructions (Fig. 5).

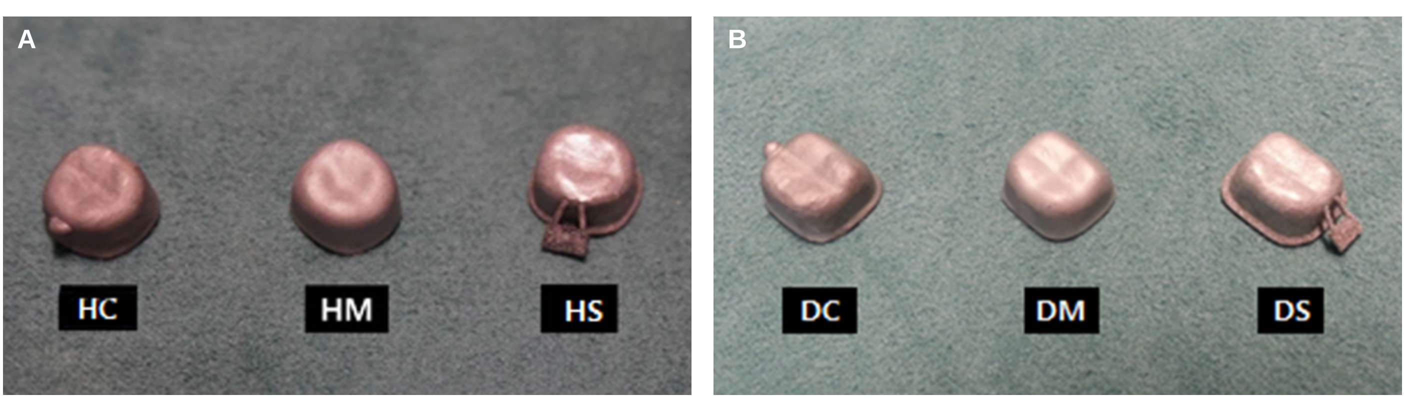

Fig. 3. Copings produced by three different fabricating method; selective laser sintering, milling and casting. (A) HS, HM and HC from the hand preparation model, (B) DS, DM and DC from the computer designed model.

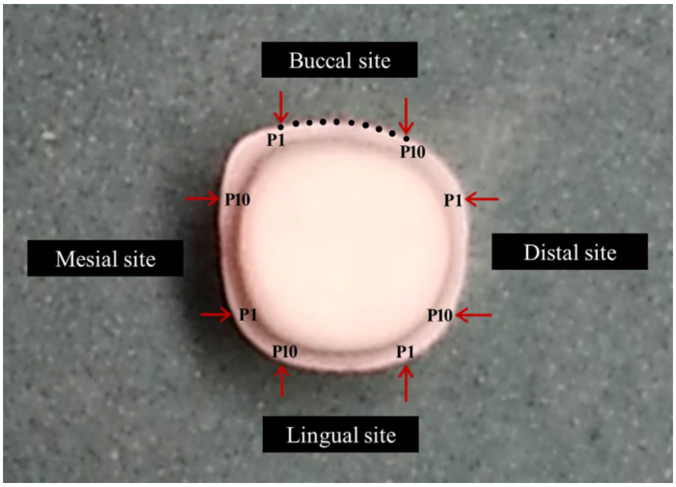

Fig. 4. Reference points on the margin of the master model.

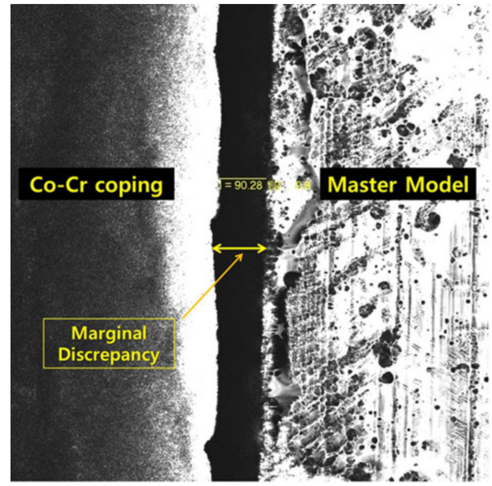

Fig. 5. Measurement of absolute marginal discrepancy by the confocal laser scanning microscope at ×150 magnification.

Statistical analysis

Wilcoxon / Kruskal-Wallis Tests (Rank Sums) was conducted to determine whether the absolute marginal gaps of the metal copings were significantly different between two model groups that have different accuracy of the finish lines. Furthermore, Wilcoxon rank-sum test was conducted to determine whether the absolute marginal gaps of the metal copings that were made by conventional lost wax technique, milling method or the recently introduced SLS technique were significantly different. The JMP version 11 (SAS Institute Inc., Cary, NC, USA) was used for all statistical analyses at a significance level of 5%.

Results

The mean values and standard deviations of the absolute marginal gap of the metal copings of the six groups (hand prepared and computer designed) are shown separated by the parts in Table 1. The Wilcoxon / Kruskal-Wallis test revealed that hand preparation model had greater marginal discrepancies with the copings than computer designed model in SLS (*P* value=.0231) and casting method (*P*<.0001). However, the milling groups had no significant difference between HM group and DM group (*P*=.9962) (Table 1).

For the measurement of the parts, buccal site had the biggest gap between the two models in SLS (*P*=.0002) and milling group

Table 1. Mean (SD) value of absolute marginal discrepancy for four site of the metal copings with the results of the Wilcoxon / Kruskal-Wallis Tests (unit: ㎛)

		Hand preparation model	Computer designed model	*P* value
		Mean (SD)	Mean (SD)	
SLS	Mesial	24.4 (14.5)	17.8 (8.8)	.3258
	Buccal	22.3 (10.6)	6.8 (1.5)	.0002
	Distal	9.9 (4.2)	16.8 (5.1)	.0082
	Lingual	13 (8.8)	5.9 (1.3)	.0635
	Total	17.4 (11.5)	11.8 (7.4)	.0231
Milling	Mesial	57.1 (8.2)	45.2 (20.2)	.1124
	Buccal	41.3 (19.6)	61.4 (34.9)	.3258
	Distal	47 (10.7)	32.2 (17.7)	.0588
	Lingual	63.4 (19)	76.7 (13)	.0963
	Total	52.2 (17)	53.9 (27.8)	.9962
Casting	Mesial	46.3 (13.7)	45 (25.5)	.9397
	Buccal	39.4 (17.6)	16 (5.3)	.0019
	Distal	42.9 (15.4)	7.6 (1.6)	.0002
	Lingual	92 (15.3)	6.4 (2)	.0002
	Total	55.1 (26.3)	18.8 (20)	<.0001

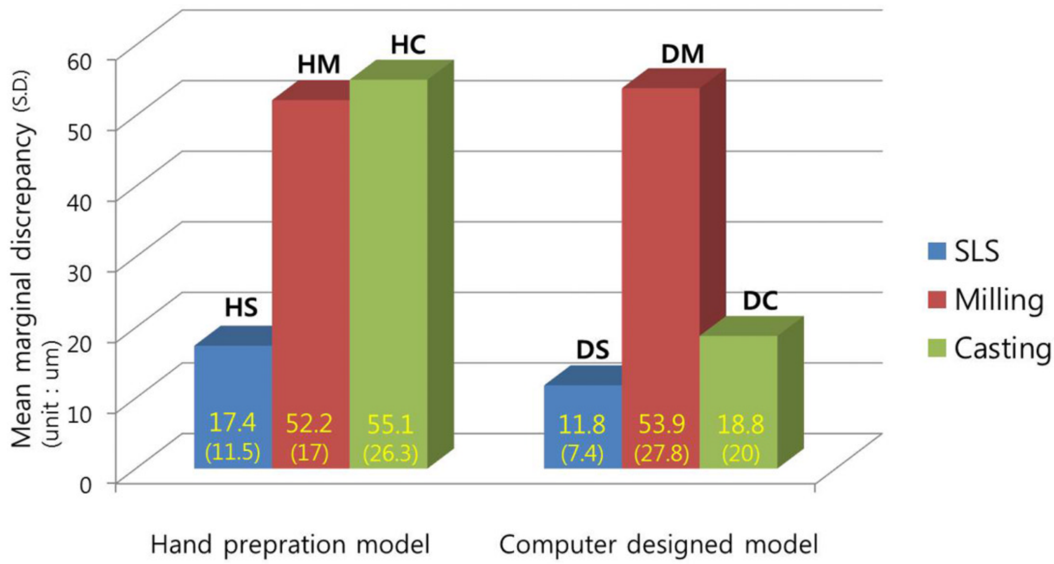

Fig. 6. Total mean (standard deviations) of absolute marginal discrepancy for metal copings from two master models. Statistically significant differences between hand preparation model and computer designed model in SLS group (*P*=.0231) and casting group (*P*<.0001).

(*P*=.3258), while the casting group had the most different mean values between the two models in lingual part (*P*=.0002) (Table 1).

According to the manufacturing method, SLS showed the smallest mean marginal gap (17.4 ㎛) followed by milling (52.2 ㎛) and casting (55.1 ㎛) in hand preparation model groups, meanwhile the order of SLS (11.8 ㎛), casting (18.8 ㎛) and milling (53.9 ㎛) was showed in the computer designed model (Fig. 6).

Discussion

Laser sintering is a type of additive manufacturing and a relatively new method compared to both casting and CAD/CAM milling technique. This is also called as the three-dimensional (3-D) printing or rapid prototyping (RP). Additive manufacturing can fabricate 3-D objects in a single stage, directly from their computer-aided design (CAD), for which X-ray CT and MR images are available.[5] Different from CAD/CAM-based cutting technology, additive manufacturing technology creates products layer by layer on the basis of sliced data from the 3-D design. A laser scans metal powders according to the sliced data to obtain a layer of products. The powders for the next layer are covered on the melted layer, and the laser scanned again according to the next sliced data. This sequence continues until the near-net-shape of the products is formed automatically. In addition, free form shaping can be achieved without mold and limitations of cutting tools in the process. Therefore, this process is expected to be applied in the fabrication of dental devices with complex geometry. It involves several advantages over the casting and the CAD/CAM technique, and it also saves the raw materials and requires fewer tools to reduce costs.[10]

The commercial laser sintering systems such as EOSINT M270,[10,16] PM 100 Dental System (PHENIX Systems, Clermont-Ferrand, France)[22,23] and BEGO MEDIFACTURING System (BEGO Medical, Bremen, Germany)[24] are recently reported in literatures. PM 100 Dental System is the first rapid manufacturing system using laser sintering of cobalt-chromium powders that is commercially available to dental laboratories for fabrication of prostheses. EOSINT M270 system also has been widely used in fabricating the cobalt-chrome fixed dental prostheses including the metal frames of removable partial dentures, and is the first system utilized for laser sintering fabrication technique of base metal restorations in Korea.

Marginal accuracy is an important factor in quality of fixed prosthodontics. Many studies about the marginal fit of various crowns have been reported, however it is difficult to compare the studies because there are many concepts regard to the marginal discrepancy.[25] Marginal gap is the shortest distance from the coping to the die surface. Horizontal marginal gap is the horizontal marginal misfit measured perpendicular to the path of draw of the coping and vertical marginal gap is the vertical marginal misfit measured parallel to the path of draw of the coping. Absolute marginal discrepancy means the distance measured from the margin of the coping to the cavosurface angle of the die.[26] In this study, absolute marginal discrepancy was measured as the angular combination of the marginal gap with a CLSM. CLSMs can measure the exact absolute marginal gap, because the apparatus can focus two points only when they are on the perpendicular surface to the laser beam. That means the distance between two points is the shortest. The other method commonly used in measuring the marginal gap is replica technique which is the measurement of the thickness of the intervention between abutment and the coping.[27,28] Disadvantage of this method is the low reliability of the value, because measurement cannot be made from various points on the circumferential margin and the boundary of silicone cannot be clear at margin.[17]

There has been few studies that evaluate the effect of the accuracy of tooth preparation on the marginal fit of the fixed prosthodontics. The aim of present study was to evaluate the relationship between those two factors and compare the capacity of the SLS method to reflect the quality of abutment preparation into the marginal fit of the prosthesis to other manufacturing methods.

The present study simulated the abutment tooth prepared perfectly with the aid of CAD/CAM, and the result showed that the marginal fit of the CAD model was better than that of the abutment model prepared by a general dentist in SLS (P=.0231) and casting method (P<.0001) (Table 1). The fact can be a cause of the result that the perfect preparation has smooth finish line at all around the margin, equiproportional radius of the axiogingival internal line angle and steady axial wall taper circumferentially, whereas the hand preparation revealed the irregular wave of running of the finish line under the microscopic view. Only milling group showed the opposite result, but the mean values have a slight difference (52.2 ㎛ for hand preparation and 53.9 ㎛ for computer designed preparation) and there is no significant difference statistically (P=.9962) (Table 1). Specimens by milling method had the biggest average marginal gap at mesial and distal side of HM group and all sides of DM group. This may be explained that it is more difficult to cut Co-Cr alloy block of milled group precisely due to its hardness. More vibration and resistance of the milling axis could affect the accuracy of milling procedure compared to the milling of the soft material like pattern resin milled in CLWT.

In the present study, the marginal gaps of metal copings from the same model were different according to the manufacturing methods (Fig. 6). The smallest mean marginal gap (17.4 ㎛ for hand preparation model / 11.8 ㎛ for CAD model) was shown in SLS manufacturing on both models (Table 1). The value was smaller than those of other studies.[15-21,29] Kim *et al*. reported the marginal gap of 75.0 ㎛ measured with the intervention of light body silicone for replica technique[17] and 128.0 ㎛ as absolute marginal discrepancy in other studies.[16] Quante *et al*. demonstrated 93 ㎛ as the marginal gap measured with silicone paste intervention.[15] Örtorp *et al*. presented the mean cement film thickness of 84 ㎛ on 3-unit fixed prostheses.[29] There are several reasons that the result of the present study showed better average marginal fits than others. The intervention of the cement hinder the coping from sitting on the abutment fully and the viscosity and flowability of each cement material effect differently on the degree and pattern of sitting.[18,20,21] In addition, the vertical marginal gap of the implant-supported crown with more simplified shape than prepared tooth had the range of 27.2 - 61.6 ㎛[20] which is similar to the result of this study.

In this study, resin tooth abutment was directly prepared by one clinician, who has the clinical experience more than ten years, and one professional examiner performed the measurement of the specimens so that the performance bias and inter-examiner variability did not occur. For further study to examine the effect of the quality of the tooth preparation on clinical result, a few testing groups can be considered that have different preparation skills like dental students and trained clinicians.

Conclusion

Within the limitation of this study, the accuracy of abutment preparation influences the marginal adaptation of Co-Cr coping in SLS system and casting group. Milling group showed inferior marginal adaptation relatively and lower sensitiveness about the accuracy of abutment preparation than SLS system and casting groups. The copings produced by SLS system exhibited the best marginal fitness among all groups, and the casting method showed the most sensitiveness about the accuracy of abutment preparation.

ORCID

Seo-Rahng Kim *http://orcid.org/0000-0003-1306-7397*
Seong-Joo Heo *http://orcid.org/0000-0003-0699-4141*
Myung-Joo Kim *http://orcid.org/0000-0003-2020-5284*

References

1. Anusavice KJ. Phillips' science of dental materials. 11th ed. Philadelphia; W.B. Saunders; 2003. p. 621-4.
2. Wataha JC. Alloys for prosthodontic restorations. J Prosthet Dent 2002;87:351-63.
3. Viennot S, Dalard F, Lissac M, Grosgogeat B. Corrosion resistance of cobalt-chromium and palladium-silver alloys used in fixed prosthetic restorations. Eur J Oral Sci 2005;113:90-5.
4. Rosenstiel SF, Land MF, Fujimoto J. Contemporary fixed prosthodontics. 4th ed. St. Louis; Mosby; 2006. p. 409, 599, 606-8.
5. Takaichi A, Suyalatu, Nakamoto T, Joko N, Nomura N,

Tsutsumi Y, Migita S, Doi H, Kurosu S, Chiba A, Wakabayashi N, Igarashi Y, Hanawa T. Microstructures and mechanical properties of Co-29Cr-6Mo alloy fabricated by selective laser melting process for dental applications. J Mech Behav Biomed Mater 2013;21:67-76.
6. Akova T, Ucar Y, Tukay A, Balkaya MC, Brantley WA. Comparison of the bond strength of laser-sintered and cast base metal dental alloys to porcelain. Dent Mater 2008;24:1400-4.
7. Ucar Y, Akova T, Akyil MS, Brantley WA. Internal fit evaluation of crowns prepared using a new dental crown fabrication technique: laser-sintered Co-Cr crowns. J Prosthet Dent 2009; 102:253-9.
8. Fasbinder DJ. Clinical performance of chairside CAD/CAM restorations. J Am Dent Assoc 2006;137:22-31.
9. Miyazaki T, Hotta Y, Kunii J, Kuriyama S, Tamaki Y. A review of dental CAD/CAM: current status and future perspectives from 20 years of experience. Dent Mater J 2009;28:44-56.
10. Suleiman SH, Vult von Steyern P. Fracture strength of porcelain fused to metal crowns made of cast, milled or laser-sintered cobalt-chromium. Acta Odontol Scand 2013;71:1280-9.
11. White SN, Sorensen JA, Kang SK, Caputo AA. Microleakage of new crown and fixed partial denture luting agents. J Prosthet Dent 1992;67:156-61.
12. Lakhani SA, Ercoli C, Moss ME, Graser GN, Tallents RH. Influence of cold working and thermal treatment on the fit of implant-supported metal-ceramic fixed partial dentures. J Prosthet Dent 2002;88:159-69.
13. Pierce LH, Goodkind RJ. A status report of possible risks of base metal alloys and their components. J Prosthet Dent 1989;62:234-8.
14. Wassell RW, Walls AW, Steele JG. Crowns and extra-coronal restorations: materials selection. Br Dent J 2002;192:199-202, 205-11.
15. Quante K, Ludwig K, Kern M. Marginal and internal fit of metal-ceramic crowns fabricated with a new laser melting technology. Dent Mater 2008;24:1311-5.
16. Kim KB, Kim WC, Kim HY, Kim JH. An evaluation of marginal fit of three-unit fixed dental prostheses fabricated by direct metal laser sintering system. Dent Mater 2013;29:91-6.
17. Kim KB, Kim JH, Kim WC, Kim HY, Kim JH. Evaluation of the marginal and internal gap of metal-ceramic crown fabricated with a selective laser sintering technology: two- and three-dimensional replica techniques. J Adv Prosthodont 2013;5:179-86.
18. Sundar MK, Chikmagalur SB, Pasha F. Marginal fit and microleakage of cast and metal laser sintered copings-an in vitro study. J Prosthodont Res 2014;58:252-8.
19. Bhaskaran E, Azhagarasan NS, Miglani S, Ilango T, Krishna GP, Gajapathi B. Comparative evaluation of marginal and internal gap of Co-Cr copings fabricated from conventional wax pattern, 3D printed resin pattern and DMLS tech: an in vitro study. J Indian Prosthodont Soc 2013;13:189-95.
20. Castillo-Oyague R, Lynch CD, Turrión AS, López-Lozano JF, Torres-Lagares D, Suárez-García MJ. Misfit and microleakage of implant-supported crown copings obtained by laser sintering and casting techniques, luted with glass-ionomer, resin cements and acrylic/urethane-based agents. J Dent 2013;41:90-6.
21. Oyague RC, Sánchez-Turrión A, López-Lozano JF, Montero J, Albaladejo A, Suárez-García MJ. Evaluation of fit of cementretained implant-supported 3-unit structures fabricated with direct metal laser sintering and vacuum casting techniques. Odontology 2012;100:249-53.
22. Akova T, Ucar Y, Tukay A, Balkaya MC, Brantley WA. Comparison of the bond strength of laser-sintered and cast base metal dental alloys to porcelain. Dent Mater 2008;24:1400-4.
23. Al Jabbari YS, Koutsoukis T, Barmpagadaki X, Zinelis S. Metallurgical and interfacial characterization of PFM Co-Cr dental alloys fabricated via casting, milling or selective laser melting. Dent Mater 2014;30:79-88.
24. Xin XZ, Chen J, Xiang N, Wei B. Surface properties and corrosion behavior of Co-Cr alloy fabricated with selective laser melting technique. Cell Biochem Biophys 2013;67:983-90.
25. Holmes JR, Bayne SC, Holland GA, Sulik WD. Considerations in measurement of marginal fit. J Prosthet Dent 1989;62:405-8.
26. Suárez MJ, González de Villaumbrosia P, Pradíes G, Lozano JF. Comparison of the marginal fit of Procera AllCeram crowns with two finish lines. Int J Prosthodont 2003;16:229-32.
27. Molin M, Karlsson S. The fit of gold inlays and three ceramic inlay systems. A clinical and in vitro study. Acta Odontol Scand 1993;51:201-6.
28. Rahme HY, Tehini GE, Adib SM, Ardo AS, Rifai KT. In vitro evaluation of the "replica technique" in the measurement of the fit of Procera crowns. J Contemp Dent Pract 2008;9:25-32.
29. Ortorp A, Jonsson D, Mouhsen A, Vult von Steyern P. The fit of cobalt-chromium three-unit fixed dental prostheses fabricated with four different techniques: a comparative in vitro study. Dent Mater 2011;27:356-63.

지대치 삭제의 정확도가 레이저 신터링 기술로 제작된 Co-Cr 코핑의 변연적합도에 미치는 영향

김서랑 · 곽재영* · 허성주 · 김성균 · 김명주

서울대학교 치과대학 치과보철학교실

목적: 본 연구의 목적은 지대치 삭제의 정확도와 metal coping의 변연적합도와의 상관관계를 알아보는 데 있다. 이를 통해, 세 가지 다른 제작 방식 (주조, milling, 기법)이 이 상관관계에 미치는 영향을 비교해 보고자 한다.

재료 및 방법: 두 개의 master medel을 서로 다른 방식으로 제작하였다; 첫 번째 모델은 치과의사에 의해 deep chamfer margin을 가지도록 지대치 삭제된 것이고, 두 번째 모델은 3-D designing software program을 이용하여 동일한 삭제원칙에 따라 제작되었다. 각각의 모델에 대하여 세 가지 제작 방식으로 코발트-크롬 코핑을 12개씩 제작하여, 총 72개의 시편을 얻었다. 각 시편을 master model상에 적합시키고 공초점 레이저 주사 현미경으로 변연적합도를 측정하였다.

결과: SLS system (*P*=.0231)과 주조방식(*P*<.0001)에서는 computer designed model이 hand prepared model에 비하여 유의하게 우수한 변연적합도를 보였다. 그러나 milling group에서는 두 모델 간에 유의한 차이를 나타내지 않았다(*P*=.9962).

결론: 본 연구에 한하여, 지대치 삭제의 정확도가 금속 코핑의 변연적합도에 미치는 영향은 그 제작 방식에 따라 달랐다. 제작 방식에 따른 변연적합도는 SLS system이 가장 우수하였고 지대치 삭제의 정확도에 의해 영향을 받았다. 한편, milling 방식은 세 가지 방식 중 가장 큰 변연 격차를 나타내었으며 지대치 삭제의 정확도에 영향을 받지 않았다. *(대한치과보철학회지 2015;53:337-44)*

주요단어: 지대치 삭제의 정확도; 변연적합도; 코발트-크롬 코핑; 치과용 selective laser sintering; 치과용 CAD/CAM

*교신저자: 곽재영
03080 서울시 종로구 대학로 101 서울대학교 치과대학 치과보철학교실
02-2072-3027: e-mail, young21c@snu.ac.kr
원고접수일: 2015년 7월 30일 / 원고최종수정일: 2015년 9월 21일 / 원고채택일: 2015년 10월 1일