Comparison of palatal fit of dentures fabricated by injection-molding techniques versus rapid prototyping and milling

Suji Lee, Younghoo Lee, Jaeseung Shim, Kwantae Noh, Janghyun Paek, Ahran Pae, Hyeong-Seob Kim, Kung-Rock Kwon
Dept. of Prosthodontics, School of Dentistry, Kyung Hee University, Seoul, Korea

I. Background
The aim of this study was to compare the adaptation of denture bases fabricated by three methods: injection-molding, rapid prototyping and milling.

II. Material and Methods
4 notches were formed using #2 carbide round bur on the maxillary edentulous model. The model was replicated using silicone based duplication material (n=10). The models were scanned and the denture bases designed using CAD software. Denture bases were fabricated by three method: injection-molding, rapid prototyping and milling. The intaglio surfaces of denture bases fabricated on each replicate cast were digitized by using the model scanner. Surface matching software was used to measure dimensional changes between each cast and its corresponding denture base. The one-way ANOVA was performed to determine differences among groups. Statistical significance was inferred when P<.05 to compensate for multiple group comparisons.

III. Results and Discussion
No differences at distance between notches were observed between the groups. Statistically significant differences in palatal discrepancies and degrees of fine expression were observed between injection-molding, rapid prototyping and milling. The adaptation offered by rapid prototyping and milling group was significantly higher than that offered by injection-molding group. Degree of fine expression offered by injection-molding group was significantly higher than that offered by other groups.
Application of 3D printing in removable prosthodontics; Current status and clinical application

Hyun-Ji Hwang1), Young-Eun Cho1), Chikahiro Ohkubo2), Sung-Kyun Kim3), Eun-Jin Park1)

1)Department of Prosthodontics, School of Medicine, Ewha Womans University, Seoul, Republic of Korea, 2)Department of Removable Prosthodontics, School of Dental Medicine, Tsurumi University, Yokohama, Japan 3)Department of Prosthodontics, School of Dentistry, Seoul National University, Seoul, Republic of Korea

I. Background
Alongside the development of digital devices and computer-aided design / computer-aided manufacturing (CAD/CAM) technology, the concept of digital dentistry has been applied throughout the whole field of prosthetic dentistry. Even for removable prostheses, numerous CAD/CAM studies continue to improve conventional denture production. The most up-to-date method of three-dimensional (3D) printing, which refers to the additive manufacturing process, has no limitations with regarding the design of geometric shapes compared with conventional methods. Denture fabrication using CAD/CAM systems can make it easy to collect the patient’s data. Also, it can aid in the quick and efficient manufacturing of spare prostheses based on the stored data. In addition, patients who require such complicated maxillofacial treatments can be treated in their vicinity with the help from a distant specialist. The purpose of this study was to assess the tissue surface adaptation of 3D printed denture bases compared with that of conventional pack and press denture bases, and to further explore the use of CAD/CAM 3D printing technology in maxillofacial prosthesis by applying it to a patient.

II. Material and Methods
In this study, twenty maxillary and mandibular denture bases were virtually designed on reference casts and were manufactured based on CAD data using 3D printing technique. Then 20 conventional dentures were fabricated using pack and press method. 3D images were obtained from the intaglio surfaces of the denture specimens and superimposed using a 3D inspection software. To compare tissue surface adaptation and deviation, data were analyzed and color deviation maps were extracted. Statistically significant differences were detected with respect to tissue surface adaptation of the denture bases (P<.001).

III. Results and Discussion
In a clinical case, a 90-year-old woman visited the Department of Prosthodontics, Ewha Womans University Mokdong Hospital, Seoul, Korea with a completely edentulous state with an ill-fitting prosthesis covering a left maxillary defect that was made 10 years ago. The patient’s CT was taken and the model made by conventional methods was scanned in Korea. The CT and the scanned data were then sent to the Department of Removable Prosthodontics, Tsurumi University, Yokohama, Japan to design the obturator with a hollow space. The design data were sent back to Korea to be printed with a 3D printer and was successfully delivered.

In the in-vitro study, the 3D printed denture bases showed better fit than the conventionally fabricated ones with a 100-µm accuracy and smaller interquartile range. In the clinical application, the maxillofacial obturator with a hollow space manufactured was 3D printed and finally delivered. Although there were some limitations and while further research is necessary, they depict the advantages and potential of CAD/CAM 3D printing technology in restoring maxillary defect, especially in that distant institutes and dental labs may cooperate with one another.
I. Background

It is considerably hard to achieve the retention, support, and stability of a denture in a class III edentulous case with severe alveolar resorption and extensive flabby tissue formation.

Flabby tissue is a state of the anterior gingiva transformed into inflammatory state from continuous stimuli, which affects the stability of the denture by lack of hard tissue support. Non-pressure mucostatic impression technique or impression followed by surgical excision of the flabby tissue have been used in an attempt to overcome this matter. However, the original cause of flabby tissue formation needs to be eliminated, otherwise it will relapse with time.

II. Material and Methods

This patient’s chief complaint was the frequent dislodgement of dentures and unsatisfactory mastication. The dentures were fabricated in an unauthorized non-medical facility, and was not in a suitable form for usage, with severe wear of the artificial teeth and loss of fit of the mucosal surface. In the maxilla, flabby tissue and severe alveolar resorption was observed on the anterior and premolar area. The patient also showed class III relationship with mandibular protrusion. The treatment objective of this case was to distribute the forces focused on maxillary anterior area with stable bilateral support of the posterior area.

Temporary dentures were fabricated to evaluate the teeth arrangement and denture function. Sufficient clearance was given on the anteriors to relief the occlusal stimuli, and the posteriors were arranged in a form to prevent dislodgement during wax denture try-in. The patient proceeded to the final denture fabrication, for anterior clearance was maintained throughout temporary denture usage, and teeth arrangement was thought to be suitable after the denture dislodgement test.

III. Results and Discussion

This case is reported because of the favorable treatment results that showed improvement of the dislodgement and uncomfortable mastication of the dentures by enhanced denture fit and crossbite arrangement of the posteriors.
Effects of artificial aging on the biaxial flexural strength of Ce-TZP/Al2O3 and Y-TZP after various occlusal adjustments

Hag-young Lee, Il-Gwang Sim, June-sung Shim, Jee-hwan Kim

Yonsei University Department of Prosthodontics

I. Background
The aim of this study was to determine the effect of aging on the biaxial flexural strength (BFS) of Ce-TZP/Al2O3 and Y-TZP after occlusal adjustment.

II. Material and Methods
NanoZr block (Ce-TZP/Al2O3 nanocomposite) and Katana zirconia block (Y-TZP) were prepared by milling with the aid of CAD/CAM into disk-shaped specimens. For each type of zirconia, 16 specimens were prepared without grinding for the control group (diameter of 16 mm and thickness of 1.20 ± 0.05 mm, mean ± SD), while 48 specimens were prepared for 3 experimental groups (n=16 each; 16 mm in diameter and 1.50 ± 0.05 mm thick) with different types of surface grinding: superfine diamond bur (group I), zirconia stone bur (group II), and zirconia stone and fine polishing bur (group III). These specimens underwent an aging process in a steam autoclave for 5 h at 0.2 MPa and 134 °C, and then X-ray diffractometry was applied along with measurements of surface roughness and BFS. After occlusal adjustment, the monoclinic phase percentage increased in 3 experimental groups.

III. Results and Discussion
Overall the increase was greater for Ce-TZP/Al2O3 than for Y-TZP. The Ra value showed similar changes for both types of zirconia. Following the aging process, Y-TZP showed a greater increase in the monoclinic phase percentage, but the change was not statistically significant. The Ra value showed similar changes in both types of zirconia, with no significant differences between before and after the aging process. The results of the BFS test showed that applying the aging process after grinding significantly increased the strength of both types of zirconia, with Ce-TZP/Al2O3 being significantly stronger than Y-TZP. The specimens treated by a superfine diamond bur exhibited the highest BFS in the four tested groups. Ce-TZP/Al2O3 had a higher BFS and greater resistance to low-temperature degradation than did Y-TZP.
In-vitro study of the fracture resistance of monolithic lithium disilicate, monolithic zirconia, and lithium disilicate pressed on zirconia for three-unit fixed dental prostheses

Byung-Suk Jung, Jae-Won Choi, Young-chan Jeon, Chang-Mo Jeong, Mi-Jung Yun, So-Hyoun Lee, Jung-Bo Huh*

Department of Prosthodontics, School of Dentistry, Pusan National University, Yangsan, Republic of Korea

I. Background
The purpose of this study was to determine fracture resistance and failure modes of three-unit fixed dental prostheses (FDPs) made of lithium disilicate pressed on zirconia (LZ), monolithic lithium disilicate (ML), and monolithic zirconia (MZ).

II. Material and Methods
Co-Cr alloy three-unit metal FDPs model with maxillary first premolar and first molar abutments was fabricated. Three different FDPs groups, LZ, ML, and MZ, were prepared (n = 5 per group). The three-unit FDPs designs were identical for all specimens and cemented with resin cement on the prepared metal model. The region of pontic in FDPs was given 50,000 times of cyclic preloading at 2 Hz via dental chewing simulator and received a static load until fracture with universal testing machine fixed at 10°. The fracture resistance and mode of failure were recorded. Statistical analyses were performed using the Kruskal-Wallis test and Mann-Whitney U test with Bonferroni's correction (α=0.05/3=0.017).

III. Results and Discussion
A significant difference in fracture resistance was found between LZ (4943.87 ± 1243.70 N) and ML (2872.61 ± 658.78 N) groups, as well as between ML and MZ (4948.02 ± 974.51 N) groups (P<.05), but no significant difference was found between LZ and MZ groups (P>.05). With regard to fracture pattern, there were three cases of veneer chipping and two interfacial fractures in LZ group, and complete fracture was observed in all the specimens of ML and MZ groups. Compared to monolithic lithium disilicate FDPs, monolithic zirconia FDPs and lithium disilicate glass ceramics pressed on zirconia-based FDPs showed superior fracture resistance while they manifested comparable fracture resistances.
Assessment of the fit and patient satisfaction of lithium disilicate crowns fabricated with three different CAD/CAM systems

Dae-Sung Kim, Young-Chan Jeon, Chang-Mo Jeong, Mi-Jung Yun, So-Hyoun Lee, Jung-Bo Huh

Department of Prosthodontics, School of Dentistry, Pusan National University, Yangsan, Republic of Korea

I. Background

Recently, the development of dental CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) system has changed the manufacturing method of fixed prosthesis. In particular, in the field of dental prosthetics, it has been widely applied to treatment planning, surgery, and prosthetic restoration. Recently, the demand for CAD/CAM system has been increasing to reduce the use of various materials, production time and cost. The purpose of this study was to evaluate the patient satisfaction, precision and fitness of lithium disilicate restorations (IPS e.max CAD, Ivoclar Vivadent, Amherst, NY) made by CEREC (Bensheim, Germany), DDS (Seoul, Korea), 3Shape (Copenhagen, Denmark) among various CAD/CAM systems.

II. Material and Methods

Of the patients who visited the Department of Prosthodontics in Pusan National University Dental Hospital, forty patients who needed dental restoration due to dental caries or tooth fracture were included in this study. Three restorations were made for each abutment using three CAD/CAM systems. For the precision evaluation, STL (stereolithography) file designed by CAD and STL file obtained by scanning the inside of actual processed restoration were compared using three-dimensional superimposition analysis (3D systems, Rock Hill, USA). In marginal and internal fitness evaluation, the silicone replica obtained by the replica technique was cut in the mesiodistal and buccolingual directions, and the internal and marginal gaps were measured using an image analysis program (i-solution, IMT, Canada). One-way ANOVA and Tukey’s test were used to analyze statistical significance between groups.

III. Results and Discussion

In this study, the precision and fit of lithium disilicate restorations fabricated with three CAD/CAM systems were compared. The marginal and internal fit of all 120 restorations were in the clinically acceptable range. DDS group showed the best marginal and internal fit, followed by 3Shape and CEREC (p < 0.05). The 3Shape group showed better results than the DDS group in the evaluation of machining precision (p < 0.05), but there was no significant difference between the groups in the patient satisfaction comparison (p > 0.05). In addition, further studies on the long-term prognosis of restorations made with CAD/CAM systems will be needed.
A novel method to analyze 3-dimentional accuracy of complete-arch dental impression

Kweonsoo Seo, Sunjai Kim

Department of Prosthodontics, Gangnam Severance Dental Hospital, College of Dentistry, Yonsei University, Seoul, Korea

I. Background

Accurate impression taking is one of the crucial factors for successful prosthetic restoration. Different impression materials and impression techniques have been used to make the accurate reproduction of intraoral environment. Since the introduction of dental CAD-CAM, various intraoral scanners were developed and used in clinical practice. Many studies evaluated the accuracy of digital impression using different intraoral scanners. Most studies used “Best fit alignment” to compare the accuracy of digital impressions. However, best fit method inherently included superimposition errors, which is commonly overexaggerated or sometimes underestimated in complete-arch models.

In the current study, 3-dimensional coordinate systems were used to measure the linear and angular distortion of conventional and digital impression techniques to exclude the inherent errors while superimposing digital models to compare the amount of distortion. Further, the errors while converting the physical data to digital data were also excluded by using this method. The purpose of this study was to evaluate the accuracy of complete-arch impression with digital and conventional impression techniques by using a newly developed analyzing method and verify the validity of the new method to evaluate the accuracy of complete-arch impressions.

II. Material and Methods

For master model, customized fourteen cylinders (diameter : 5mm, length : 15mm) made of PEEK were manufactured and all resin teeth were removed on upper jaw typodont models. After properly filled the extraction sites with utility wax, impression was taken with 2-step putty wash technique. Epoxy was used to pour the model. Then fourteen holes (diameter 5.5mm, length 10mm) were made using implant drilling kit to insert the PEEK cylinders. Cylinders were fixed using acrylic resin. For conventional method, impressions were taken from the master model with a polyvinylsiloxane impression material and individual tray. Type IV stone (MG Crystal Rock, Maruishi Gypsum Co, Japan) was used to pour the model. Fifteen models were made with same method. For digital models, impressions were taken from the master model with intraoral scanner (Trios 3, 3shape, USA). Scanning was done by manufacturer’s instructions without scanning spray and files were saved as STL (stereolithography) format. Fifteen models were made with same method.

Measurement of master models were done by CMM. Three dimensional coordinates of center of cylinders’ top (Centroids) were calculated using software. Then mean value was determined as reference value. In the same way, measurement of conventional impression method group was done by CMM. And measurement of intraoral scanner group was done by software with STL files. Differences of three dimensional coordinates of centroids between master model and conventional impression, master model and digital impression were analyzed.

III. Results and Discussion

For reliability test, all test showed 1.0. It meant all measurements had almost perfect reproducibility. For three dimensional coordinates of centroids differences between groups, independent two sample t-test was used and two groups showed significantly statistically difference. But the results showed conflict with each other by tooth position. This results could not show that which one was better. So additionally, linear mixed model analysis was performed, the results showed conflict with each other.

In this study, the digital impression and the conventional impression were compared to their accuracy in edentulous model with 14 PEEK cylinders by CMM without superimposition process. Accuracy measurement without superimposition process will facilitate accuracy evaluation of further scanners or impression materials.
Fixture level evaluation of digital and conventional impression of multiple dental implants on complete edentulous maxillary model

Kyoung-Rok Kim1), Kyung-Young Seo1), Jai-Young Koak2), Sunjai Kim1)

1)Department of Prosthodontics, Gangnam Severance Dental Hospital, College of Dentistry, Yonsei University, Seoul, Korea, 2)Department of Prosthodontics, School of Dentistry, Seoul National University, Seoul, Korea

I. Background
Passive fit on implant prosthesis reduces the possibility of mechanical and biological complications, making them an important factor for its long-term success. Although it is difficult to get a complete passive fit, obtaining an accurate implant impression can reduce the misfit of prosthesis. With the development of digital technologies in the dental field, digital impressions using intra-oral scanner have become as reliable as conventional impressions on short span fixed dental prosthesis. In particular, no study has been conducted to evaluate the accuracy of digital impression by multiple implants at the implant fixture level. In this study, the accuracy of implant impression obtained by intra-oral scanners in the complete edentulous maxillary model with six implants was compared with conventional impression at the implant fixture level.

II. Material and Methods
As a reference model, a complete edentulous maxillary model with six implants (#16i, #14i, #12i, #22i, #24i, #26i) was fabricated with epoxy resin. Ten digital test models were created by scanning the reference model using an intra-oral scanner (Trio III, 3Shape) with polymer scan body. Ten conventional test models were made by obtaining conventional impressions of the reference model with splinted technique and individual tray. At the implant fixture level, the reference model and conventional models were measured with a coordinate measuring machine (CONTURA, Zeiss), and digital models were measured with 3D inspection software (Geomagic control 2015, 3D SYSTEMS). The distance and angular variations among the implants of these measurements were compared to assess the accuracy of implant impression on the same coordinate system. The statistical analysis was performed with independent sample t-test and one way ANOVA. For the post hoc test, the Scheffe’s method was used.

III. Results and Discussion
The displacement of distance in the centroid of the analogue was shown in the conventional model at 59.4±11.7 μm and in the digital model at 144.3±39.2 μm, respectively (P = .05). There was a significant difference in the displacement of distance between the two groups. The angular displacement of the long axis of the analogue was evaluated by obtaining the angle displaced in the Y direction and the angle in the Z direction based on X axis. The angular displacement in the Y direction was -0.210±1.183˚ in the conventional model and -1.138±1.940˚ in the digital model, and in the Z direction was -0.052±0.180˚ in the conventional model and -0.356±0.195˚ in the digital model, respectively. The angular displacement of the analogue long axis showed significant different only in the Z direction between two groups. As a result of one way ANOVA in digital model, the accuracy of the impressions was significant difference depending on the location of implant analogue. Scheffe’s method showed significant differences in central distance displacement between # 26i and # 14i, 16i, 22i as well as #16i and #26i also.

In this study, the digital impression and the conventional impression were compared to their accuracy in complete edentulous maxillary model with six implants at implant fixture level. In complete edentulous model, digital impression was less reliable compared to conventional impression. The accuracy of the implant impression using the intra-oral scanner was also different depending on the location of the implant.
I. Background
The image information of missing teeth is used in optically based medical equipment in prosthodontic treatment. To evaluate oral scanners, the standard model (basic model) was examined from cases of image recognition errors of linear discriminant analysis (LDA), and a model that combines the variables with reference to ISO 12836:2015 was designed. The LDA techniques presented above are the most widely used methods in face recognition. A dental scanner scans the model, continuously. In case of a program that combines images, the order that the photographer takes the model from one place to the next cannot be confirmed. To solve this problem, the model can be reproduced by avoiding the errors of the LDA, given the variable factors. This study designed a model that modified ISO 12836:2015 and applied variable factors to the abutment teeth in order to implement a standardized model cast that can evaluate the accuracy of the scanner for the entire arch. In addition, this paper presents analysis based on the case of image recognition errors of LDA method obtained data after capturing the models.

II. Material and Methods
This study prepared specimens on dentiform, imitating the shapes of the teeth and mandibular arch. The basic model was fabricated by applying to the tooth profile and the bottom surface. With the basic model, four variable factors were selected such as chamfer cylinder in the form of a cutting surface on the axial surface, groove cylinder in the form with a groove and bevel on the occlusal surface, curve on the base, and square curve. Eight cases were made and the plaster model was manufactured. In this research, photo-type and video-type scanners were used to analyze 3D images of eight cases after image capture. The errors in each image were then analyzed. Images of the dental stone model were collected in the following sequence, occlusal, buccal, and lingual. The direction of progress was decided in specimens. The scans were performed 10 times according to the prescribed sequence to distinguish the model from the one that did not form, and the results confirmed it to be the best.

III. Results and Discussion
This study considered a basic model, tooth profiles, and variable factors on the base surface and analyzed each model through the cases of errors in image recognition with LDA. In the case of the initial basic model, a 3D shape could not be obtained by scanning even if several shots were taken. It is essential to avoid the formation of the same pattern because the recognition rate of the image was improved with every variable factor and the difference depends on the tooth profile and the pattern of the floor surface. Differentiating each class when producing a standardized model is a method that can avoid errors in image recognition. Based on the recognition error of the LDA, the recognition rate decreases when the model has a similar pattern. Therefore, to obtain the accurate 3D data, the difference of each class needs to be provided when developing a standardized model.
Prediction of the learning curves of dental CAD software

KeunBaDa Son1,2), Kyu-Bok Lee1,2,3)

1) Advanced Dental Device Development Institute, Kyungpook National University, Daegu, Republic of Korea, 2) Department of Dental Science, Graduate School, Kyungpook National University, Daegu, Republic of Korea, 3) Department of Prosthodontics, School of Dentistry, Kyungpook National University, Daegu, Republic of Korea

I. Background
Dental clinical procedures are being replaced by digital workflows. Therefore, the time necessary to learn dental computer-aided design (CAD) software to achieve a change in the digital workflow should be evaluated. Long-term learning effects can be predicted using an easy method and a short time, without inefficient repeated experiments. In this way, it is possible to evaluate the working efficiency of a medical device and the effectiveness of clinical learning while observing the improvement speed of the learner. The purpose of this study was to predict the learning curve according to the type of dental CAD software with the Wright model and to determine the rate of improvement in the learner's working time with iterative learning.

II. Material and Methods
A total of 40 participants with various degrees of experience with dental computer-aided design and computer-aided manufacturing (CAD-CAM) systems were recruited. The four specified steps of a custom abutment design were performed with 3DSystem CAD software and EXO CAD software and were repeated 3 times in stages. The times were analyzed with repeated measures 1-factor and repeated measures 2-factor analysis. The learning time for 300 design iterations was estimated by applying the Wright model formula, and the 300-repetition times were analyzed with the Mann-Whitney U test (α=.05).

III. Results and Discussion
EXOCAD had a longer mean learning time than the 3DSystem. The overall change with repeated learning was significantly different (P<.001), and all differences were found in the first to the third iterations. Software-dependent differences were also observed (P=.005). The Mann-Whitney U test also revealed a significant difference between the 2 software programs (P=.015), but no significant difference was found after the 56th iteration (57th iteration: P=.051).

As the time reduction patterns for iterative learning differs depending on the type of CAD software, the learning curves may differ according to the type of software. As the operator's skill increased through iterative learning, the differences in learning times between the software programs gradually disappeared.
Implant restoration with unfavorable location and axis on anterior maxillary region

Seung-Hoe Jeong, Sunjai Kim, Jae-Seung Chang

Department of Prosthodontics, Gangnam Severance Dental Hospital, College of Dentistry, Yonsei University, Seoul, Korea

1. Background

For implant prosthesis, angulation and position of implant is crucial factor. If implants are not placed in proper angulation and position, esthetic and functional restorations are hard to be expected. Especially, in anterior dentition, implant should be placed to palatally for harmonized emergence profile. In case of buccally placed implant, buccal bone could not help being thinned so abutment or fixture exposure might be happened if marginal bone loss was progressed.

Cement or screw retained prosthesis have its own characteristics. Screw retained prosthesis have retrievability so repair or cleansing is easy but also have dependence of implant angulation or orientation.

Meanwhile, cement retained prosthesis are independent on implant angulation or position but excessive cement can cause complications like marginal bone loss.

In this case, various methods were tried for implant prosthesis restoration with unfavorable location and axis on anterior maxillary region.

2. Case Report

In this case, 74 years old woman came to make prosthesis at i13, i11, i21 implants. At digital teeth arrangement analysis, implant restorations were estimated by unfavorable location and axis on anterior maxillary region. Various treatment plans were tried and finally, cement retained zirconia veneered porcelain bridge restoration using CAD/CAM abutments were decided. To get the adequate position and angle of abutment, CAD/CAM abutments were chosen. CAD/CAM abutments were designed using design software (Dental designer premium, 3shape, USA). After milling of CAD/CAM abutments, they were connected to definitive cast and scanned again. On the basis of design using software (inLab 15.1, Sirona, Germany), cement retained porcelain veneered zirconia bridge prosthesis fabrication was determined due to screw hole orientation. Coping was designed, milled, sintered and adjusted to definitive cast. But small amount of CAD/CAM abutment exposure was seen at right canine area and this might be due to thin buccal gingiva and abutment screw insertion path. At first, margin was planned to be placed at sub-gingiva but screw damage was expected. So margin had no choice but to be placed at supra-gingiva. To match the cervical gingiva line, pink shade porcelain was added. After occlusal adjustment and polishing, jig which was tool for repositioning was made using acrylic resin (Pattern resin, GC, Japan). At setting appointment, healing abutments were retrieved and CAD/CAM abutments were set using jig. And prosthesis was set to patient with temporary cement (Temp bond, Kerr, USA).

For prosthetic restoration on unfavorable location and axis of implants, there were limitations although various methods were tried.

3. Results and Discussion

In this case of unfavorable location and axis of implants which were buccally placed in anterior maxillary region, restoration was made using CAD/CAM abutments and cement retained type porcelain veneered zirconia bridge as a result of various trials. Although titanium abutment was seen on right canine cervical area, considering abutment screw insertion path due to abutment inclination and thin buccal gingiva, there was no other way to cover this area though using CAD/CAM abutment or various trials. Four unit cantilever bridge restoration with not using right canine fixture could be alternative but various complications like cement wash out were expected derived from long leverage.
Prosthetic restoration in MRONJ patients: Case reports

Hyun-ji Bang1), Seong-Joo Heo2), Eun-Jin Park1)

1) Department of Prosthodontics, School of Medicine, Ewha Womans University, Seoul, Republic of Korea, 2) Department of Prosthodontics, School of Dentistry, Seoul National University, Seoul, Republic of Korea

1. Background
Medication-related osteonecrosis of the jaw (MRONJ) is a severe adverse drug reaction. Its observable main symptom is progressive bone destruction in the maxillofacial region. MRONJ is often associated with anti-resorptive drugs, among others, which are used to treat osteoporosis and bone metastasis.

Severe alveolar bone loss due to surgical removal of MRONJ-infected sites makes subsequent prosthetic treatment difficult. Therefore, consideration in the treatment planning stage should be given to obtain satisfactory support and retention of prostheses. MRONJ is also difficult for surgeons because of the high recurrence rate and implant failure after surgical intervention. To obtain a successful healing, medicine discontinuation before surgery, sequestrectomy using PRF (platelet-rich fibrin) and BMP (bone morphogenic protein) graft, and thorough follow-up after surgery is necessary.

The purpose of this presentation is to discuss the factors to consider for successful prosthetic restoration cases in MRONJ patients.

II. Material and Methods
In the first case, a 72-year-old female patient had severe alveolar bone loss on her right mandible due to sequestrectomy for MRONJ treatment. After evaluating hard and soft tissue healing, careful evaluation of the retention and support of the prosthesis was needed due to the severe bone loss of the surgical site. Implant-retained mandibular overdenture was planned and fabricated to reinforce the retention and support by Arch-Friction-Soft system.

In the second case, an 84-year-old woman received sequestrectomy on her left maxilla and right mandible with a PRF and BMP graft. Using temporary dentures, evaluation of the soft and hard tissues were conducted through follow-up. To restore defects on the maxilla and mandible, final restorations consisting of a maxillary complete denture and a mandibular removable partial denture were delivered.

III. Results and Discussion
Both of these cases showed satisfactory esthetic and functional results. More careful observation and management of hard and soft tissue is required in the treatment of MRONJ patients and this particular situation should be considered in the prosthetic treatment planning stage. Combined effort from surgeon and prosthodontist is the key for successful rehabilitation of patients with severe bone loss due to MRONJ.
Effect of surface removal following bleaching on the bond strength of enamel

Yi-Ling Cheng, Hui Cheng, Hao Yu

Department of Applied Prosthodontics, Graduate School of Biomedical Sciences, Nagasaki University, Japan

I. Background
This study aimed to evaluate the effect of surface removal following bleaching on the micro-shear bond strength (μSBS) of bleached enamel.

II. Material and Methods
Forty-eight specimens were prepared from bovine incisors and were randomly divided into 2 groups (n = 24): group B (bleaching with 40% hydrogen peroxide for 2 x 45 min with a 1-week interval) and group C (control group without bleaching treatment). Immediately after receiving the treatments, 0.5 mm of the enamel was removed from the specimen surface, followed by bonding of the enamel surface with composite resin. Each group was further divided into 2 subgroups of 12 specimens each: subgroup T (with 5,000 thermocycles in water baths at 5°C and 55°C), and subgroup N (without thermocycling). The μSBS values were measured using a universal testing machine and subjected to two-way analysis of variance (α = 0.05). The fracture modes of the specimens were observed using a stereomicroscope.

III. Results and Discussion
The μSBS values of the different groups ranged from 21.42 to 25.21 MPa. Bleaching treatment and thermocycling did not significantly affect the μSBS values (P = 0.348 and P = 0.507, respectively). No significant interaction was found between the bleaching treatment and thermocycling (P = 0.514). All the groups exhibited a high percentage of mixed failures.

Conclusion. The results suggested that the bonding procedure could be performed on the bleached enamel following a surface reduction of 0.5 mm immediately after the bleaching treatment.
Antifungal activity of tea extractions and its application in denture cleaning

Jing-Jing Huang, Ming Zheng

School of Stomatology, Fujian Medical University, Fuzhou, China

I. Background

The purpose of this study was to investigate the susceptibility of Candida albicans (C. albicans) to different tea extractions, analyzing and comparing 4 kinds of catechins content in AG, TM, and HM (Anji white tea: AG, Tie Guanyin: TM, Da Hong Pao: HM) for revealing the relation between tea extractions’ antifungal activity and catechins content. Finally, To evaluate the capacity of tea extractions on reducing the Candida albicans biofilm which were adhesion in the polymethyl methacrylate (PMMA) surface. Verifying the possibility of tea extractions become denture cleansers and antifungal drugs, therefore providing clinical guidance.

II. Material and Methods

(1) Using the agar dilution method board, different concentrations of three teas (Anji white tea: AG, Tie Guanyin: TM, Da Hong Pao: HM) were prepared, final tea supernatant concentrations were 1.25, 2.50, 5.00, 10.00, and 20.00 mg/mL. Sterilized distilled water was used in the control group. By virtue of tablet coating method, C. albicans was planted on tablets. The growth of C. albicans colonies were then detected by counting the number of colonies growing on Sabouraud's dextrose medium. Data was analyzed by using both One-Way ANOVA with the significance level of 5%, and least Significant difference (LSD test).

(2) High performance liquid chromatography (HPLC) method system was used to analyze and compare 4 kinds of catechins content in AG, TM and HM. Chromatographic conditions were as follow: ZORBAX SB – C18 (5.0 μm, 4.6 mm × 150.0 mm) was used, the mobile phase was 1% acetonitrile–methanol and the flow rate was 1 mL/min, at the detection wavelength of 280 nm, and the column temperature was 30 centigrade.

The same specifications PMMA (10.0 mm × 20.0 mm × 2.5 mm) specimens which contained Candida albicans biofilm were randomly distributed into the 4 groups and soaked in 10.0 mg/mL AG (Anji white tea: AG), 2.5 mg/mL HM (Da Hong Pao: HM) and 0.5% sodium hypochlorite solution (positive control group), sterile water (negative control group) in ten minutes. After treated, the Candida albicans, which were adhesion of the specimen, were cultured. The number of colonies growing on Sabouraud's dextrose medium was counted, in order to compare tea extractions clearance of Candida albicans biofilm. Data was analyzed by using both One-Way ANOVA with the significance level of 5%, and least Significant difference (LSD test).

III. Results and Discussion

(1) The results showed that the inhibitory effect of 10.0 mg/mL AG, 2.5 mg/mL HM were significant (P <0.05), but the rest teas of different concentrations were not significant (P>0.05); (2) There was a good linear relationship between the concentration and peak area (r ≥ 0.9991). The average recoveries were range from 97.75% to 100.39%. RSD was less than 5.00%(n=3). AG has highest tea catechins content in three kinds of tea extractions. HM’s epigallocatechin gallate (EGCG), epicatechin (EC), epicatechin gallate (ECG) content higher than TM’s. TM’s epigallocatechin (EGC) content higher than HM. (3) The result of colony counting was not significantly different among sterile water, 10.0 mg/ml AG (P=0.979) and 2.5 mg/ml HM (P=0.652). 0.5% sodium hypochlorite solution had no colony growth.

Conclusion: (1) 10.0 mg/mL Anji white tea and 2.5 mg/mL Da Hong Pao can inhibit C. albicans effectively, Tie Guan Yin has no effect on inhibiting activity of C. albicans. (2) Speculation, tea extractions of antifungal activity may be associated with tea catechins content. (3) Both 10.0 mg/mL AG and 2.5 mg/mL HM have no effect of inhibitory Candida albicans biofilm from the PMMA surface.
Reconstructed maxillofacial prosthesis framework by selective laser melting and metallic cytotoxicity study

Yan Dong¹, Wei Peng², Leiqing Zhang¹, Xigen Yuan², Xianfeng Jiang², Yi-Jun Dai¹

¹Dept.of prosthodontics, College of Medicine, The Second Affiliated Hospital, Zhejiang University, Hangzhou, China. ²Key Laboratory of Special Purpose Equipment and Advanced Manufacturing Technology Ministry of Education, Zhejiang University of Technology, Hangzhou, China.

I. Background
The purpose of this study was to investigate the feasibility of manufacturing the framework of maxillofacial prosthesis by SLM(Selective laser melting) technique as well as the cytotoxicity of 3D-printed metallic specimens which made of nichrome, cobalt-chromium and titanium alloy.

II. Material and Methods
The digital model of 5 patients with maxillary and partially dentition defects were obtained by scanning dental casts in STL format. The framework of prosthesis were drew in Rihnoceros and Geomagic, while pre-procedures like the support and position of framework were designed in Magics. Prosthesis framework printed by SLM technique was compared with the one made by traditional dewaxing casting technique, in sitting and fitting on the cast. The pontics, obturator and denture base were manufactured by traditional lab work. The standard specimens of nichrome, cobalt-chromium and titanium alloy were made by SLM technique and dewaxing casting technique respectively, whose cytotoxicity were tested by MTT method.

III. Results and Discussion
The 3D-printed prosthesis framework was complete in structure, precise in try-in and accurate in clinical application. Patients were satisfied with the comfort of final prosthesis. The cytotoxicity revealed by MTT method, of specimens from 3D-printed and dewaxing casting nichrome, cobalt-chromium and titanium alloy, were all within the permitted level for clinical application, which met the requirements for dental metallic materials.

Conclusion: The SLM 3D-printing technique is feasible for manufacturing the framework of prosthesis; No cytotoxicity was found for SLM printed specimens of nichrome, cobalt-chromium and titanium alloy.
Research of a novel tissue-engineered bone in dental implantation

Yandong Mu, Lijuan Huang, Wei Qing, Qiang Tuo

Stomatology Department, Sichuan Provincial People’s Hospital, University of Electronic Science and Technology of China

I. Background
A novel tissue-engineered bone that 3-D porous hydroxyapatite scaffolds (HAW) was developed using sugar sphere as porogens, which has excellent osteoconductive and osteoinductive potential in our previous research.

To evaluate the osseointegration of dental implant at different time point inserted in HAW, which prior to be inserted for repairing canine segmental mandibular bone defects three months ago.

II. Material and Methods
Eight beagle dogs were randomly divided into two groups, bilateral mandibular premolars were extracted and two cylindrical bone defects of 8 mm in diameter and 10 mm in height were created. The HAW was inserted in one side as test group, while autologous bone was used to fill the other side as control group. Three months later, a diameter of 4.0mm * 10mm implants were embeded into the middle of repair area. Four weeks and twelve weeks after implantation, imaging, histological and biomechanical methods were taken to evaluate the osseointegration of dental implant.

III. Results and Discussion
A well implant-osseous healing was identified in both test and control group by X-ray and CBCT at 12 weeks, while the control group showed a higher neogenetic bone density around the implant. Micro-CT indicated a significant higher density difference in control’s compared to the test one at four weeks (P<0.05), while the discrepancy disappeared at 12 weeks (P>0.05), which suggested similar conjunction were formed between the implant and the autologous bone as well as the HAW. Histologically, at four weeks both groups showed new bone formation, and lots of mature bone trabecula around implant thread at twelve weeks, simultaneously having detected Harvard tubule. No significant mechanical-strength difference was found in between two groups (P>0.05).

Conclusions: The HAW in vivo alone could induce new bone formation, thus might be a favorable remediation to repair bone defects. Moreover, they could achieve fine osseointegration between implants and HAW.
Influence of thickness and low-temperature degradation on properties of dental zirconia

Ziyuan Zhu, Yuqiong Wu

Department of Prosthodontics, Ninth People’s Hospital, Shanghai Jiaotong University, School of Medicine

I. Background

The aim of this study was to evaluate the influence of thickness and degradation on the mechanical properties of different zirconia.

II. Material and Methods

4 zirconia ceramics (Lava Frame, In-ceram, Zenostar, Upcera), were cut into 23mm (Length) x 4mm x 0.8mm and 1.5mm and artificially aged for 10 and 20 hours. Specimens were divided into 24 groups by different porcelain thickness (0.8mm, 1.5mm) and aging time 0hours (as control), 10hours and 20hours.

SEM and X-ray diffraction was used to estimate the relative amount of monoclinic phase specimens. Three-point flexure strength and Vickers hardness of specimens were tested.

III. Results and Discussion

(1) With the aging time extending, the surface defects and micro-cracks of specimen became more obvious, particularly in 20h group. 0.8mm group showed more significant defects and micro-cracks. (2) The XRD results revealed an increase in the monoclinic phase fraction in specimens aging with 20 hours. (3) The hardness and strength decreased significantly in specimens aging with 20 hours. Brand VITA: Bending strength was 1153.33MPa, 1116.67MPa, 940.89MPa in the 0.8mm groups after aging 0h, 10h, 20h, and 1347.66MPa, 1283.59MPa, 929.47MPa in 1.5mm groups. Brand LAVA: Bending strength was 761.72MPa, 757.79MPa, 647.23MPa in 0.8mm groups and 920.00MPa, 838.18MPa, 774.27MPa in 1.5mm groups. Brand UPCERA: Bending strength was 1054.69MPa, 932.03MPa, 844.98MPa in 0.8mm groups and 1183.33MPa, 1085.67MPa, 899.41MPa in 1.5mm groups. Brand WIELAND: Bending strength was 1042.97MPa, 972.03MPa, 889.32MPa in 0.8mm groups and 1133.33MPa, 1023.67MPa, 750.05MPa respectively in 1.5mm groups.

Conclusions:

(1) With the aging time extending, the micro-cracks on the surface of specimen were more obvious and same to the monoclinic phase.
(2) With the aging time extending, the strength and Vickers-hardness of all zirconia were reduced.
(3) 0.8mm group showed more significant defects, micro-cracks, monoclinic phase and stronger mechanic strength in spite of the aging time.
Adaptation of maxillary complete denture base plates cast from wax patterns fabricated using a three-dimensional printing (3DP) technique

Yao Yang Xiong

Department of Prosthodontics, Ninth People’s Hospital, Shanghai Jiao Tong University School of Medicine

I. Background
The aim of this in vitro study was to evaluate the adaptation of maxillary denture base plates produced using a three-dimensional printing (3DP) technique.

II. Material and Methods
We prepared thirty standardized edentulous maxillary stone casts and they were randomly divided into three groups based on the use of three different metal fabrication methods. Five wax patterns were fabricated using the 3DP technique, whereas the remaining patterns were fabricated using the conventional method. After casting, all of the denture base plates were attached to the corresponding master casts, and three transverse cuts were made through each stone cast-metal base set. The gaps between the inner sides of base plates and the surfaces of casts were measured at 9 points using a stereomicroscope.

III. Results and Discussion
When the 3 sections were compared individually (canine: 3DP=214.75±85.63 μm, CM=116.62±19.10 μm; molar: 3DP=149.34±53.09 μm, CM=140.35±83.53 μm; seal area: 3DP=235.68±105.80 μm, CM=173.94±115.17 μm), there were no statistically significant differences between the 3DP and conventional methods (p>0.05). A comparison of the mean gap widths for the conventional method (143.64±86.96 μm) and the 3DP technique (199.72±97.66 μm) revealed no significant differences in the adaptation of the base plate (p>0.05). Regardless of whether denture base plates were fabricated using 3DP (canine: 214.75±85.63 μm, molar: 149.34±53.09 μm, seal area: 235.68±105.80 μm) or the conventional method (canine: 116.62±19.10 μm; molar: 140.35±83.53 μm; seal area: 173.94±115.17 μm), there were no significant adaptation differences (p>0.05) for any of the 3 sections in each group.

Conclusion: We prepared thirty standardized edentulous maxillary stone casts and they were randomly divided into three groups based on the use of three different metal fabrication methods. Five wax patterns were fabricated using the 3DP technique, whereas the remaining patterns were fabricated using the conventional method. After casting, all of the denture base plates were attached to the corresponding master casts, and three transverse cuts were made through each stone cast-metal base set. The gaps between the inner sides of base plates and the surfaces of casts were measured at 9 points using a stereomicroscope.