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RESEARCH AND EDUCATION

Comparison of marginal and internal fit of press-on-metal and conventional ceramic systems for three- and four-unit implant-supported partial fixed dental prostheses: An in vitro study

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ABSTRACT

Statement of problem. Adaptation is an important factor in the long-term clinical success of implant supported ceramic restorations. Ceramic firings may affect the adaptation of the restoration.

Purpose. The purpose of this study was to compare the marginal and internal adaptation of 3 different restorative materials and the effect of veneering/pressing on the material used for 3- and 4-unit implant supported fixed dental prostheses.

Material and methods. One mandibular epoxy cast was prepared for 3-unit restorations and one for 4-unit restorations. Impressions of the casts were made and 60 stone die casts (30 3-unit, 30 4-unit) produced. The casts were divided into 3 subgroups: group MCR, conventional metal ceramic restorations; group POM, press-on-metal restorations; group ZIR, computer-aided design/computer-aided manufacturing CAD/CAM) zirconia restorations. A replica technique was used to examine the marginal and internal gap values. A total of 2400 measurements were made by making 40 measurements of each restoration. The data were evaluated statistically using analysis of variance and the least significant difference post hoc test (α=.05).

Results. The lowest marginal gaps were found in group POM (81.58 µm) and the highest in group MCR (103.82 µm). The differences in marginal adaptation measurements were found to be statistically significant. The highest values for internal adaptation were found at the occlusal surface in all groups.

Conclusions. Although veneering metal ceramic restorations increased the misfit of the restoration, the marginal discrepancy of the materials (81 to 120 µm) can be considered clinically acceptable. (J Prosthet Dent 2015;114:52-58)

Implant-supported fixed dental prostheses have become a well-accepted treatment option[1,2] with acceptable success rates[2] for partially edentulous patients. This success can only be achieved with a precise fit of the implant-supported restoration,[3] which is critical to the long-term success of any dental restoration.[4] The gap between the implant abutment and the restoration allows bacteria to adhere, causing inflammatory reactions in the periimplant soft tissues and biologic complications of the surrounding tissues.[4,5] In addition to the biologic complications, ill-fitting fixed implant-supported restorations cause mechanical complications such as decementation, fracture and chipping of the ceramic, or loosening of the abutment screws.[6] An imprecise fit can reduce the resistance to fracture of ceramic restorations.[7] Successful restoration fit depends on such factors as implant positioning, impression technique and accuracy, fabrication and material of framework and restoration, pontic design and width, and clinician/technician experience.[5] More accurate impression materials and techniques and more stable restorative materials after ceramic firings minimize the misfit of the restoration. A more predictable dimensional stability can be obtained with pressed porcelain materials.[8,9] Ceramic veneering has to be considered as an additional factor contributing to the total strain

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Clinical Implications

The adaptation of a metal ceramic restoration is affected by repeated ceramic firings. With press-on-metal restorations, these repetitive firings are eliminated, and therefore the adaptation of the restoration is less affected.

development of a restoration and negatively affects the precision of fit.[3,6,10-14]

Clinically acceptable misfit levels have been defined for fixed dental prostheses at between 50 and 120 μm.[3,15-17] For computer-based restorations, a marginal gap of under 200 μm has been stated to be clinically acceptable.[7,18] Some studies have found that a marginal gap of under 100 μm is clinically acceptable.[4,19] Regish et al[12] found that the marginal and internal gaps of conventional metal ceramic restorations increased after a series of ceramic firings.

The purpose of this investigation was to compare the precision of fit of different restorative materials on implant systems and to evaluate the adaptation change after ceramic veneering and pressing procedures. The null hypotheses were that marginal and internal adaptation differ according to material, fabrication procedure, and pontic width.

MATERIAL AND METHODS

Two different partially edentulous mandibular casts were fabricated from epoxy resin (Moravia; Boyman Boya Kimya Ltd). In one of the casts, the mandibular left premolars and first molar teeth were missing, and in the other, the mandibular left premolars and molars were missing. Two implants (Astra Implants, AstraTech; Dentsply Implants) were inserted in the first premolar and first molar region in the first cast, and 2 implants were inserted in the first premolar and second molar region in the second cast. The implants were positioned parallel to each other and perpendicular to the horizontal crestal plane by using a parallelometer (EWL Type 990; KaVo Dental GmbH). Impression copings were adapted over the implants and impressions were made with polyvinyl siloxane impression material (Virtual; Ivoclar Vivadent). The impression material was prepared according to the manufacturer's instructions. After setting, the impressions were removed from the casts. Thirty impressions were made for each diagnostic cast. After 1 hour at room temperature, direct abutment replicas (Astra Implants, AstraTech; Dentsply Implants) were inserted into the impression copings. To simulate gingival tissue, a gingival mask (Gingifast; Zhermack) was applied to the impression. Type IV dental stone (Heraus Kulzer GmbH) was blended in a vacuum mixer (Smartmix; AmannGirrbach) for 30 seconds at a ratio of 30 mL water to 150 g powder and was poured under constant vibration. After 2 hours of hardening, the dental stone casts were separated from the impressions. A power analysis was conducted to determine the necessary sample size. As a result, a sample size of 7 was found to be satisfactory; nevertheless, 10 specimens were fabricated for each group. A total of 60 diagnostic casts (30 each for 2 master diagnostic casts) were divided into 3 subgroups by restoration material: MCR, conventional metal ceramic restorations; POM, press-on-metal restorations; and ZIR, computer-aided design/computer-aided manufacturing (CAD/CAM) zirconia restorations (Fig. 1).

Twenty casts (ten 3-unit, ten 4-unit casts) were used to assess conventional metal ceramic restorations (MCR). Wax-elimination copings were used to standardize the fabrication conditions, placed on the implant abutments, and fixed together with wax. After waxing, the partial fixed dental prostheses were sprued to the crucible former. To remove any air bubbles, the investment material was mixed on a vibrating platform following the manufacturer's recommended proportions of powder, liquid, and water and poured into the crucible former. Twenty minutes were allowed for the mixture to set; then the ring was placed in an oven. The ring was left until the wax was completely eliminated and the ring had reached the temperature required for the casting of the nickel-chromium alloy. The ring was placed into the induction-casting machine (Seit Elettronica). To prevent crack formation, the investment was kept at room temperature and then opened. The nickel-chromium alloy was devested with airborne-particle abrasion, and the framework was trimmed with diamond rotary instruments, stones, and tungsten carbide finishing instruments. The initial impressions were made to evaluate the internal and marginal adaptation of metal frameworks, and the superstructures of restorations were fabricated. First, opaque porcelain (Vita VMK Master Opaque; Vita Zahnfabrik) was applied to metal frameworks and left to dry. The firing was performed at 960°C for 25 minutes. Dentin and enamel porcelain were applied conventionally and fired at 500°C for 25 minutes in a porcelain furnace (Ivoclar Programat; Ivoclar Vivadent). A second impression was made to evaluate the internal and marginal adaptation of the superstructures adaptation.

Twenty casts (ten 3-unit, ten 4-unit casts) were used to assess the press-on-metal restorations (POM). The metal framework casting procedure and opaque application of press-on-metal restorations were the same as for the MCR group. After opaque application, the wax was modeled to form the finished restoration, including occlusal surface details. After the wax model had been sprued, investment material (IPS Press Vest Speed Powder-Liquid; Ivoclar Vivadent) was prepared according to the manufacturer's recommendations. The investment was placed in an oven at 900°C for 1 hour and the wax

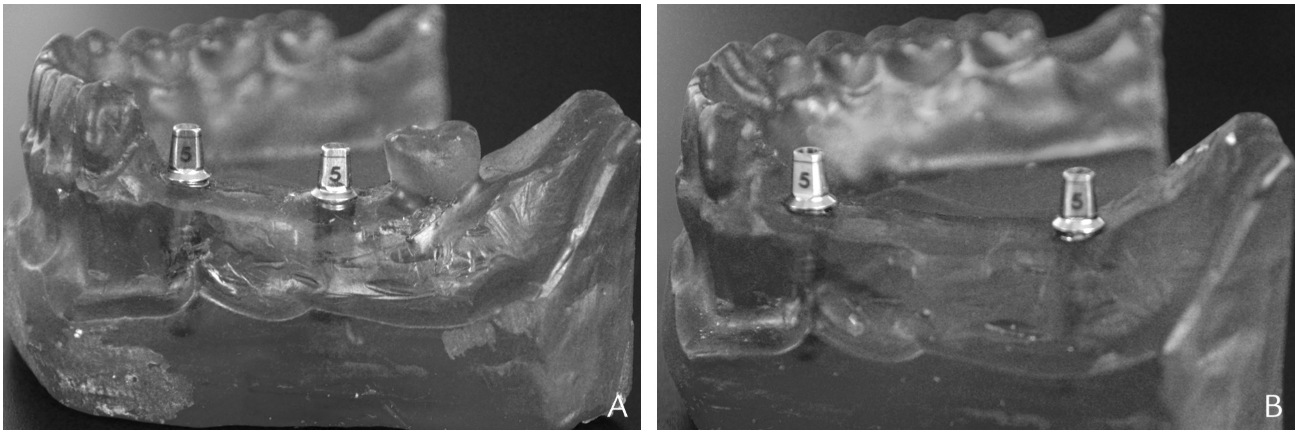

Figure 1. A, Partially edentulous mandibular model (1 tooth missing). B, Partially edentulous mandibular model (2 teeth missing).

eliminated. After the elimination procedure, the ingot (IPS InLine PoM; Ivoclar Vivadent) was pressed into the investment material.

Twenty casts (ten 3-unit, ten 4-unit casts) were used to assess the zirconia restorations (ZIR). To fabricate zirconia frameworks (IPS ZirCAD; Ivoclar Vivadent), a CAD/CAM system (Cerec inLab; Sirona Dental Systems Gmbh) was used. First, the implant located diagnostic casts were scanned with an optical camera (Cerec Bluecam; Sirona Dental Systems Gmbh). Scanned cast photographs were combined, and the definitive cast was created with a CAD program. Then zirconia frameworks were designed by means of the CAD program. The data of the design were transferred to an inLab milling program (Cerec MC XL, Sirona Dental Systems GmbH). After the milling process, the restoration was placed into a sintering oven at 1150°C for 12 hours. Anatomic contour wax modeling was performed to press the porcelain ingots (IPS ZirPress; Ivoclar Vivadent). The wax pattern was sprued and investment material was prepared. The investment was placed into a preheated oven at 850°C for 40 minutes.

A total of 60 restorations (20 metal ceramic, 20 press-on-metal, 20 zirconia) were used to evaluate the marginal and internal adaptation. For adaptation measurements, a silicone replica technique was used. The technique allowed more than one repetition because the original cast was conserved after measurement.[2,20] Silicone replicas were used to simulate the space between the restorations and implant abutments. To generate a replica; a super-light-body type A silicone impression material (Elite HD; Zhermack) was applied inside the restorations. Then restorations were placed onto the implant abutments, and maximal finger pressure was applied from the occlusal surface of the restorations. After the impression material had polymerized, the restorations were removed from the master cast. This resulted in a thin, super-light-body impression material inside the restoration that represented the discrepancy between the restoration

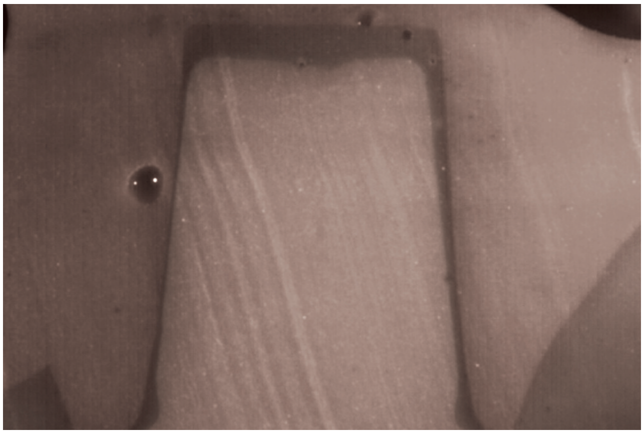

Figure 2. Microscopic image of silicone replica (×24 magnification).

and the implant abutment. To stabilize the silicone replica, a light-body type A silicone material (Elite HD; Zhermack) was injected into the super-light-body silicone material. A heavy-body type A silicone material was prepared, and the restoration was embedded into the heavy-body silicone material. Restorations were then removed from the silicone materials. Finally, a light-body silicone material was injected into the outer space of the replica for stabilization (Fig. 2).

Replicas were sectioned axially with a lancet (sterile surgical blades; Broche) in 2 directions, buccolingually and mesiodistally. Ten measurement areas (2 occlusal, 4 axial, 2 intermarginal, and 2 marginal) were determined on the cross section of the replicas (Fig. 3). From each measurement area, adaptation measurements were made from both frameworks (groups MCR, POM, and ZIR) and finished restorations (groups MCR, POM, and ZIR). For all measurements, a light microscope (Leica Optic; Leica Cambridge Ltd) at a magnification of ×24 was used. For each restoration, 40 measurements were made for a total of 2400 measurements. Statistical software was used to analyze the adaptation measurements (SPSS v11.5; IBM).

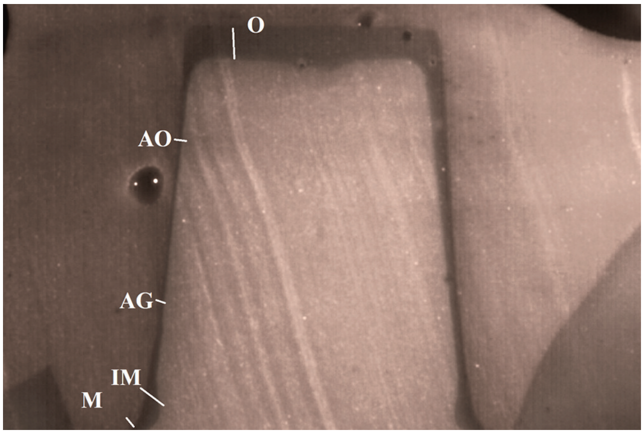

Figure 3. Gap measurement areas.

Table 1. Marginal and internal adaptation of 3 different restoration groups

Measurement Area	Group	n	Mean Gap (μm)	SD	SE	*P*
Marginal	MCR	320	89.6	23.4	5.87	.004
	POM	320	85.6	24.3		
	ZIR	320	109.3	46.4		
Intermarginal	MCR	320	129.2	14.6	1.50	.228
	POM	320	122.8	27.5		
	ZIR	320	132.9	33.7		
Axiogingival	MCR	320	100.9	21.3	4.73	.011
	POM	320	92.5	18.2		
	ZIR	320	87.1	20.7		
Axioocclusal	MCR	320	100.4	18.8	18.17	<.001
	POM	320	90.0	21.2		
	ZIR	320	75.7	14.6		
Occlusal	MCR	320	366.3	95.9	33.05	<.001
	POM	320	266.1	115.8		
	ZIR	320	193.9	68.0		

MCR, conventional metal ceramic restoration; POM, press-on-metal restoration; ZIR, computer-aided design/computer-aided manufacturing zirconia restoration.

Differences in the means of continuous measurements were tested by repeated measures analysis of variance (ANOVA). The relationships among restoration materials, restoration unit numbers, frameworks, and finished restorations were assessed with 3-way ANOVA and the least significant difference test (α=.05).

RESULTS

The internal and marginal adaptation measurements of all study groups are shown in Tables 1 to 5.

Mean marginal gap values of 89.60 ±23.43 μm for MCR, 85.57 ±24.31 μm for POM, and 109.30 ±46.44 μm for ZIR restorations were recorded. Marginal gap values recorded in ZIR were significantly higher than those in MCR (*P*<.05) (Tables 1, 2). MCRb showed statistically significantly lower marginal gaps than MCRa. ZIRa showed statistically significantly lower marginal gaps than ZIRb (Table 4). Intermarginal gap values showed no significant differences in comparison with restoration groups (*P*>.05) (Tables 1, 2). ZIRa showed statistically significantly larger gaps than ZIRb, but no significant differences were found among the other groups (*P*<.05) (Tables 3, 4). Axial measurements were divided into 2 subgroups (axiogingival and axioocclusal). For axiogingival measurements, MCR showed significantly larger gaps than ZIR (*P*<.05) (Tables 1, 2). No significant differences were found between frameworks and finished restorations in all groups (*P*>.05) (Tables 3, 4). For axioocclusal measurements, MCR showed significantly larger gaps than POM and ZIR groups. The ZIR group showed significantly lower gap values than the MCR and POM groups (*P*<.05) (Tables 1, 2). No significant differences were found between frameworks and finished restorations in all restoration groups (*P*>.05) (Tables 3, 4). Occlusal gap measurements showed larger gaps (275.4 μm) than the other measurement areas. The MCR group showed significantly larger occlusal gaps than the other groups, and the ZIR group showed significantly lower occlusal gaps than the MCR and POM groups (*P*<.05) (Tables 1, 2). MCRb showed significantly larger occlusal gaps than MCRa (*P*<.05) (Tables 3, 4).

Table 2. Comparison of marginal and internal adaptation of restoration groups

Measurement Area	Material Comparison	*P*
Marginal	MCR versus POM	.577
	MCR versus ZIR	.007
	POM versus ZIR	.001
Intermarginal	MCR versus POM	.268
	MCR versus ZIR	.520
	POM versus ZIR	.082
Axiogingival	MCR versus POM	.068
	MCR versus ZIR	.003
	POM versus ZIR	.241
Axioocclusal	MCR versus POM	.015
	MCR versus ZIR	<.001
	POM versus ZIR	.001
Occlusal	MCR versus POM	<.001
	MCR versus ZIR	<.001
	POM versus ZIR	.001

MCR, conventional metal ceramic restoration; POM, press-on-metal restoration; ZIR, computer-aided design/computer-aided manufacturing zirconia restoration.

Four-unit restorations showed larger internal and marginal gaps (except for occlusal gaps) than 3-unit restorations, but the difference was not statistically significant (except for axiogingival measurements) (*P*>.05) (Table 5).

DISCUSSION

Marginal and internal adaptation is considered one of the most important criteria for the clinical success of implant-supported partial fixed dental prostheses.[3] In this study, a

Table 3. Marginal and internal adaptation of frameworks and finished restorations

Measurement Area	Group	n	Mean Gap (μm)	SD	SE	*P*
Marginal	MCRa	160	75.4	16.6	5.26	<.001
	MCRb	160	103.8	20.6		
	POMa	160	89.6	29.1		
	POMb	160	81.6	18.3		
	ZIRa	160	120.4	54.5		
	ZIRb	160	98.2	34.6		
Intermarginal	MCRa	160	125.4	16.0	2.35	.045
	MCRb	160	132.9	12.4		
	POMa	160	128.6	31.9		
	POMb	160	116.9	21.5		
	ZIRa	160	142.7	39.9		
	ZIRb	160	123.1	23.2		
Axiogingival	MCRa	160	98.3	24.6	1.99	.085
	MCRb	160	103.4	17.8		
	POMa	160	91.8	17.4		
	POMb	160	93.2	19.5		
	ZIRa	160	87.6	25.1		
	ZIRb	160	86.7	15.8		
Axioocclusal	MCRa	160	96.8	18.8	7.52	<.001
	MCRb	160	104.0	18.7		
	POMa	160	90.1	17.3		
	POMb	160	90.0	24.9		
	ZIRa	160	74.7	17.6		
	ZIRb	160	76.7	11.2		
Occlusal	MCRa	160	335.6	101.6	14.85	<.001
	MCRb	160	397.1	81.0		
	POMa	160	247.6	107.0		
	POMb	160	284.7	124.0		
	ZIRa	160	183.7	80.6		
	ZIRb	160	204.1	52.7		

MCR, conventional metal ceramic restoration; POM, press-on-metal restoration; ZIR, computer-aided design/computer-aided manufacturing zirconia restoration.

Table 4. Marginal and internal adaptation of the frameworks and finished restorations

Measurement Area	Comparison	*P*
Marginal	MCRa versus MCRb	.005
	POMa versus POMb	.428
	ZIRa versus ZIRb	.030
Intermarginal	MCRa versus MCRb	.359
	POMa versus POMb	.154
	ZIRa versus ZIRb	.019
Axiogingival	MCRa versus MCRb	.434
	POMa versus POMb	.831
	ZIRa versus ZIRb	.887
Axioocclusal	MCRa versus MCRb	.218
	POMa versus POMb	.983
	ZIRa versus ZIRb	.731
Occlusal	MCRa versus MCRb	.041
	POMa versus POMb	.214
	ZIRa versus ZIRb	.494

MCR, conventional metal ceramic restoration; POM, press-on-metal restoration; ZIR, computer-aided design/computer-aided manufacturing zirconia restoration.

Table 5. Marginal and internal adaptation of 3-unit and 4-unit restorations

Measurement Area	Group	n	Mean Gap (μm)	SD	SE	*P*
Marginal	3 unit	480	91.3	32.1	1.23	.270
	4 unit	480	98.3	36.6		
Intermarginal	3 unit	480	123.7	26.1	3.70	.057
	4 unit	480	132.9	26.5		
Axiogingival	3 unit	480	89.7	20.1	4.18	.043
	4 unit	480	97.3	20.8		
Axioocclusal	3 unit	480	87.5	19.2	0.40	.528
	4 unit	480	89.9	22.5		
Occlusal	3 unit	480	296.3	117.4	3.82	.053
	4 unit	480	254.6	116.2		

replica technique was used to evaluate the marginal and internal gaps at different fabrication stages and with different restorative materials. The replica technique is less costly and time consuming than other techniques for generating test specimens.[4,20] In addition, the evaluations can be performed at different stages of the fabrication process because the original diagnostic cast is conserved.[20] This was critical for our study because the preservation of the original cast was necessary for comparisons. The type of microscopes and magnification ratio used by investigators for the evaluation of marginal gap varies considerably. In our study, the microscopic analysis was performed with a light microscope at ×24 magnification, and the measurements were made at ×51.4 magnification.

Theoretically, the internal space necessary for the cement is 20 to 40 μm.[21] In this study, a 30 μm die spacer thickness was used in the CAD program for the zirconia-based restorations. For metal frameworks, a plastic elimination coping system was used, eliminating the need for a die spacer application.

Metal ceramic and ceramic systems can be used for implant-supported partial fixed dental prostheses. The clinical adequacy of metal ceramics has been reported in many studies.[21-24] Witkowski et al[11] stated that the ceramic veneering of metal frameworks causes an increase in marginal and internal gaps. Regish et al[12] found that ceramic firings negatively affects the adaptation of metal ceramic restorations. Kim et al[3] indicated that the high temperature generated by the veneering porcelain firing process increases the gap of metal ceramic partial fixed dental prostheses. The press-on-metal system was thought to prevent the negative affects on adaptation caused by ceramic firings. Fahmy and Salah[9] stated that press-on-metal ceramic restorations have superior marginal adaptation than veneered metal ceramic restorations. Holden et al[8] found that marginal adaptation of veneered metal ceramics are worse than press ceramics because of ceramic firings. In this study, a mean marginal gap of 75.4 μm was recorded for metal frameworks, and after veneering, a mean marginal gap of 103.8 μm was recorded for the same restorations. For the frameworks of press-on-metal restorations, the mean marginal gap value was 89.6 μm, and, after ceramic pressing, the mean marginal gap value was 81.6 μm. Many have stated that a gap of between 50 and 120 μm is clinically acceptable for internal and marginal adaptation.[3,16,17] In this study, all axial and marginal gap values for all restoration systems were at clinically acceptable levels.

The marginal gaps of ceramic crowns have been reported as between 65.9 and 168 μm.[11,20,25,26] Wolfart et al[18] and Reich et al[7] stated that marginal gap values under 200 μm are clinically acceptable for CAD/CAM, all-ceramic restorations. However, Att et al[20] and Bindl and Mormann[19] stated that marginal gap values of under 100 μm are clinically acceptable for CAD/CAM-generated all-ceramic restorations. Karl et al[6] claimed that superstructures fabricated by conventional methods such as casting failed to achieve a passive fit. When multiunit fixed restorations were fabricated with the CAD/CAM technique, greater accuracy of fit was achieved. According to Karl et al,[10] ceramic veneering was reported to negatively affect the precision of fit of implant-supported partial fixed dental prostheses. Dittmer et al[13] and Kohorst et al[14] showed that ceramic veneering negatively affected the marginal and internal fit of 4-unit zirconia restorations. However, Vigolo and Fonzi[27] reported that porcelain firing cycle did not affect the marginal fit of 4-unit CAD/CAM-fabricated zirconia restorations. In this study, marginal gap values of 120.4 μm for zirconia frameworks and 98.2 μm after ceramic pressing were recorded. This situation created a statistically significant difference.

Passive fit is considered to be a uniform space that facilitates seating without compromising retention and resistance forms. Passive fitting can prolong the lifetime of the restoration. Imprecise internal fit can cause higher risks for veneering fracture. Martins et al[21] stated that occlusal fit may play a significant role in the structural durability of partial fixed dental prostheses, and the axial wall gap can influence the retention of partial fixed dental prostheses. In this study, a mean axial wall gap of 101 μm for metal ceramic partial fixed dental prostheses, a mean axial gap of 91 μm for press-on-metal partial fixed dental prostheses, and a mean axial gap of 81 μm for CAD/CAM zirconia partial fixed dental prostheses were reported.

In most of the clinical investigations, the widest gaps were found at the occlusal surface.[5,7] Kahramanoglu and Kulak-Ozkan[5] reported mean occlusal gap values of 281 μm for metal frameworks and 348 μm for zirconia frameworks. In the present study, mean occlusal gap values were 291 μm for metal frameworks and 183 μm for zirconia frameworks. After the fabrication of superstructures, a mean occlusal gap of 397 μm was recorded for veneered metal ceramic restorations and of 285 μm for press-on-metal ceramic restorations. Also, a mean occlusal gap of 204 μm was determined for CAD/CAM-generated pressed zirconia restorations.

CONCLUSIONS

Within the limitations of this study, the following conclusions can be drawn:

1. Mean marginal gap measurements were 103.8 μm ±20.6 for conventionally veneered metal ceramic restorations, 81.6 μm ±18.3 μm for press-on-metal ceramic restorations, and 98.2 μm ±34.6 μm for CAD/CAM zirconia restorations. These mean values are considered clinically acceptable.
2. When the measurements before and after the fabrication of superstructures were compared, the ceramic veneering process statistically increased the marginal gaps. Pressing ceramic to metal/zirconia frameworks had no negative effect on marginal and internal adaptation.
3. Occlusal gap measurements were the highest values as determined by internal adaptation measurements. Mean occlusal gap values were 397.1 μm ±81.0 μm for conventionally veneered metal ceramic restorations, 284.7 μm ±124.0 μm for press-on-metal ceramic restorations, and 204.1 μm ±52.7 μm for CAD/CAM zirconia restorations.
4. All the materials tested in this study can be used clinically.

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Noteworthy Abstracts of the Current Literature

Effect of cantilevers for implant-supported prostheses on marginal bone loss and prosthetic complications: Systematic review and meta-analysis

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Purpose. The aim of this study was to conduct a systematic review and meta-analysis to evaluate the influence of cantilevers upon implant-supported fixed partial dentures on marginal bone loss (MBL) and prosthetic-related complications.

Materials and Methods. An electronic literature search was conducted in the PubMed database by two reviewers (LTM and AM) for articles written in English from June 2003 to January 2013 that were prospective human clinical trials with the clear purpose of appraising the effect of implant-supported fixed partial prostheses on peri-implant bone level and prosthetic complications. Data from the selected studies were extracted to carry out the statistical analysis.

Results. Following the method described earlier, from initial research of 643 studies, 4 human clinical studies met the inclusion criteria and provided enough data to include them in the present meta-analysis. For the overall data, the pooled weighted mean (WM) of the MBL was 0.72 mm (range, 0.49 to 1.10 mm), with a 95% confidence interval (CI) of 0.36 to 1.08 mm. For the chi-square test, P = .60, representing a low heterogeneity among studies. MBL around implant-supported restorations with and without cantilevers was not found to be significant between both groups. The weighted mean difference (WMD) was 0.10 mm (favoring the noncantilever group), with a 95% CI = -0.18 to 0.39 mm (P = .47). For the chi-square test, P = .97, also indicating a low degree of heterogeneity between the studies.

Conclusions. The dearth of scientific evidence in this matter does not permit clear conclusions to be drawn. However, within the limitations, marginal bone loss does not seem to be influenced by the presence of cantilever extensions. Moreover, minor technical complications were found when a cantilever was present when compared to the control groups.