Comparing Retention and Internal Adaptation of Different Implant-Supported, Metal-Free Frameworks

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Purpose: This study was conducted to compare the fit and retention of implant-supported, metal-free copings fabricated from zirconia, polyetheretherketone (PEEK), or composite, as well as to evaluate the possible correlation between internal adaptation and retention. ***Materials and Methods:*** A total of 36 copings were milled from zirconia, PEEK, or composite blanks (n = 12 in each group). Marginal and internal gap were evaluated by replica technique, and the pull-out test was used to evaluate retention. One-way analysis of variance, post hoc Tukey tests, and Pearson correlation coefficient test were used to analyze the data. ***Results:*** Zirconia had significantly better marginal/internal adaptation ($P < .05$) than the other materials. There was no statistically significant difference in mean retention force between the different groups ($P > .05$). No correlation was found between internal adaptation and retention. ***Conclusion:*** In the metal-free copings tested, zirconia showed the best adaptation. The retention of copings was not influenced by internal fit or material type. *Int J Prosthodont 2018 (3 pages). doi: 10.11607/ijp.5800*

Esthetic factors play a decisive role when choosing dental treatment options. Mechanical properties that affect clinical longevity of restorations,[1] such as adaptation and retention, should be considered in new metal-free esthetic materials. Polyetheretherketone (PEEK), a high-performance polymer with low solubility, water absorption, and plaque formation in addition to good stability, stiffness, and easy fabrication procedure, is a new metal-free material in dentistry.[2] In addition, computer-aided design/computer-assisted manufactured (CAD/CAM) composite resins are reported to have better marginal adaptation, higher fracture resistance, easier fabrication, and repairing capabilities—but lower success rates—compared to glass-ceramics.[3,4] This study was conducted to compare the fit and retention of implant-supported, metal-free CAD/CAM copings fabricated from zirconia, PEEK, or composite, as well as to evaluate the possible correlation between fit and retention.

Materials and Methods

A total of 36 straight implant abutments with 5.5-mm height and 6-degree taper (Ufit Dental implant system) were torqued to their analogs, which were mounted in acrylic. The samples were randomly divided into 3 groups of 12 implants each. Using a dental laboratory scanner (3Shape D810), scanning data were transferred to CAD software (3Shape CAD design software). The die spacer was set at 30 μm starting 0.5 mm above the finish line. Copings were anatomically designed with a loop on the occlusal surface for the retention test. The copings were milled from zirconia (presintered zirconia, Ceramill Zi, Amann Girrbach), PEEK (Bio-Hpp, bredent), or composite blanks (breCAM-HIPC); zirconia copings were sintered to full density at a temperature of 1,450°C for 10 hours.

For measurement of internal and marginal fit, replica technique was applied using extra-light and heavy-body silicone material (Panasil initial contact X-Light and putty fast set). A stereomicroscope (Leitz) was used to measure the thickness of the peripheral silicone layer at ×75 magnification (Fig 1). Copings were cemented using Temp-Bond provisional cement (Kerr) under a 50-N load for 10 minutes and incubated under 100% humidity at 37°C for 24 hours. A universal testing machine (Zwick/Roell Z050) with a crosshead

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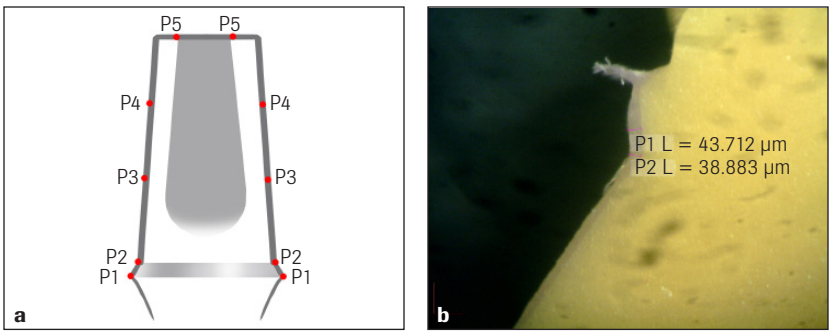

Fig 1 **(a)** Points used in each specimen for measuring the internal and marginal adaptation. P1 = marginal; P2 = margino-axial transition; P3 and P4 = axial; P5 = occlusal points. **(b)** P1 and P2 adaptation under stereomicroscope shown by dinocapture software.

Table 1 Internal Gap (µm) of Zirconia, PEEK, and Composite Groups at Different Measurement Points

Group/point	Minimum	Maximum	Mean	SD
Zirconia (n = 12)				
P1 (marginal fit)	40.01	128.63	92.0803	25.52452
P2	35.79	121.23	85.7545	24.49042
P3	17.44	42.38	33.1605	8.11089
P4	24.75	52.20	36.8103	7.82246
P5	53.18	230.58	143.4728	41.16896
Internal gap	33.93	101.07	74.7995	17.00942
Peek (n = 12)				
P1 (marginal fit)	67.27	356.95	187.5190	94.65140
P2	72.55	263.40	153.9753	66.73070
P3	32.05	95.43	48.4081	16.79196
P4	42.29	91.06	62.4212	15.60936
P5	234.85	630.33	460.7383	146.96406
Internal gap	107.25	259.81	181.3857	55.02373
Composite (n = 12)				
P1 (marginal fit)	137.24	250.28	187.3618	31.76838
P2	146.14	232.32	196.0314	24.85766
P3	28.09	100.20	40.6893	19.48229
P4	44.14	63.01	53.0732	6.49453
P5	294.91	668.79	409.7525	111.20693
Internal gap	135.99	244.24	174.8866	31.39546

The mean internal gap of zirconia (74.80 µm) was significantly lower than that of PEEK (181.39 µm) and composite (174.89 µm) ($P < .05$). SD = standard deviation.

speed of 0.5 mm/minute was used to measure the retention. One-way analysis of variance (ANOVA), post hoc Tukey honest significant difference (HSD) test, and Pearson correlation coefficient test were used for data analyses.

Results

The mean internal and marginal gaps of zirconia were significantly lower than for both the PEEK and composite groups; no statistically significant difference was found between the latter two groups (Table 1). The mean retention force recorded for zirconia was higher than the other groups (Fig 2); however, this difference was not statistically significant ($P > .05$). Pearson test showed no correlation between internal adaptation and retention force (Table 2).

Discussion

Due to growing patient demands for esthetics, nonmetallic dental restorations were introduced to dentistry and their quality has been improved over the years. However, evaluating their physical and clinical properties calls for more extensive studies. Clinically acceptable marginal gap has been reported to be

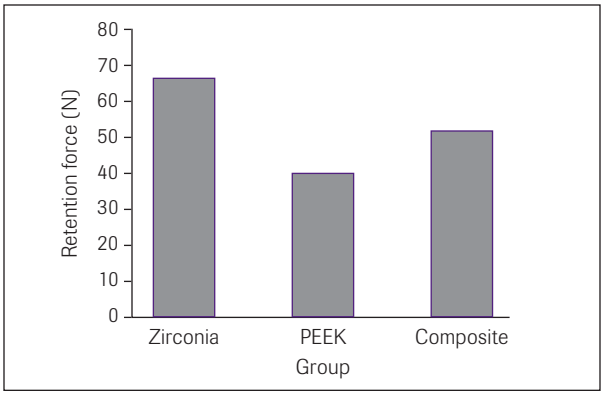

Fig 2 The mean retentive forces of zirconia (66.67 N), PEEK (39.8 N), and composite groups (52.43 N).

Table 2 Correlation Between Retention and Internal Adaptation

	Retention	Internal fit
Retention		
Pearson correlation	1	−0.121
Sig. (2-tailed)		0.481
No.	36	36
Internal adaptation		
Pearson correlation	−0.121	1
Sig. (2-tailed)	0.481	
No.	36	36

less than 120 μm,[5] and acceptable internal adaptation has been suggested to be between 50 and 100 μm.[6] The results of the present study show that the material composition of metal-free, CAD/CAM-made, implant-supported copings has no statistically significant influence on retention, but significantly affects marginal and internal adaptation. While the marginal gap of zirconia copings was in acceptable clinical range, the gaps in composite and PEEK samples were too much to be considered clinically acceptable. It was also shown that the internal adaptation of a restoration and the retentive force have no significant correlation with each other.

Bae[7] reported significantly better internal and marginal fit in polyetherketoneketone (PEKK) copings compared to zirconia, while de Paula Silveira[8] reported better internal adaptation for composite resin compared to a ceramic group. This controversy could be attributed to different types of scanners, milling machines, blanks, or blocks than those used in the present study.

The results of this study suggest that the properties of new metal-free materials should be further improved before they are proposed as long-term definitive esthetic restorative materials.

Conclusions

Considering the limitations of the present study, the following conclusions can be made:

- Zirconia copings demonstrated significantly better and clinically acceptable fit compared to PEEK and composite samples ($P < .05$).
- PEEK and composite copings did not show clinically acceptable marginal gap.
- PEEK copings had the least marginal and internal adaptation. The difference between PEEK and composite samples was not statistically significant.
- Zirconia copings were more retentive compared to composite or PEEK frameworks; however, the differences were not statistically significant.
- The internal adaptation and the retentive force had no significant correlation.

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