The Effect of Framework Design on Fracture Resistance of Metal-Ceramic Implant-Supported Single Crowns

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This study evaluated the effect of framework design on the fracture resistance of metal-ceramic implant-supported crowns. Screw-retained molar crowns with a screw access hole composed of metal or porcelain were compared to a cement-retained crown (control). For each group (n = 10), five crowns were subjected to dynamic loading (1,200,000 × 100 N × 2 Hz at 37°C). Afterward, all specimens were loaded to failure using a universal testing machine. Significant differences could be established between the cement- and screw-retained groups ($P \le .05$), but no difference was found between the screw-retained groups and the specimens subjected to dynamic loading. Occlusal discontinuity of screw-retained crowns affects their resistance, and the metallic support on the screw access hole did not reinforce the crowns. *Int J Prosthodont 2010;23:350–352.*

The challenge in using implants as support for restorations in partial and unitary edentulism has given rise to several questions regarding the materials and techniques used for such rehabilitation.¹ One of these questions is related to the mechanism used to retain the restoration over the implant. Although screwretained prostheses have a long and well-documented successful history in total edentulism, cement-retained prostheses have a simplified restorative procedure, passive fit, and little esthetic and occlusal difficulties. However, they are problematic to maintain in the dental office since they cannot be removed for maintenance or flaw adjustments.¹ Considering that porcelain fracture is the most common mechanical complication for implant-supported prostheses,² the present study aimed to evaluate the effects of the framework design and artificial aging (dynamic loading) on the fracture resistance of metal-ceramic implant-supported crowns. The null hypothesis was that the framework design would not alter the resistance of the crowns.

Materials and Methods

Thirty standardized metal-ceramic implant-supported mandibular molar crowns were divided into three groups: group 1 (control) = cement-retained, group 2 = screw-retained with a metal screw access hole (SAH), and group 3 = screw-retained with a porcelain SAH (Fig 1). The framework of group 1 had a thickness of 0.5 mm, and groups 2 and 3 had a thickness of 2 mm. All crowns were 0.5-mm thick at the cervical margin, 2-mm high at the lingual margin, and extended to connect to a proximal strut 3.5-mm high, which allowed a uniform porcelain thickness of 2 mm. For group 1, crowns were cemented with resin-modified glassionomer cement (Rely-X Luting 2, 3M ESPE) over the abutments previously screwed to the implants (32 Ncm torque) and the SAH was sealed with composite resin (Filltek Z100, 3M ESPE). Specimens from groups 2 and

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Fig 1 Division of the three groups based on framework design: **(a)** cement-retained, **(b)** screw-retained with a metallic SAH, and **(c)** screw-retained with a porcelain SAH.





 Table 1
 Mean Load at Fracture (N) and Standard Deviation for Implant-Supported Screw- and Cement-Retained

 Metal-Ceramic Single Crowns*

Specimen	Cement-retained		Screw-retained, metal SAH		Screw-retained, porcelain SAH	
	Aging	No aging	Aging	No aging	Aging	No aging
1	2,408.68	2,208.98	1,077.50	1,160.00	1,229.90	1,147.50
2	1,857.59	2,602.05	1,501.67	1,695.35	1,912.36	1,691.97
3	2,204.08	2,030.94	1,056.68	1,185.40	1,628.45	1,958.91
4	2,296.62	2,034.61	1,962.81	1,992.01	1,284.51	1,189.08
5	2,183.55	2,198.65	1,543.73	1,191.00	1,005.43	1,180.49
Mean	2,190.10	2,215.05	1,428.48	1,444.75	1,412.13	1,433.59
Standard deviation	206.11	232.66	376.02	379.15	357.74	370.27
General mean	2,202.58		1,436.62		1,422.86	

SAH = screw access hole.

*Aging refers to whether the crown was subjected to dynamic loading.



Fig 2 Box plot of failure scores for groups. NS = not significant.



Fig 3 Mode fracture of crowns: cement-retained **(a)** with and **(b)** without dynamic loading, screw-retained with a metallic SAH **(c)** with and **(d)** without dynamic loading, and screw-retained with a porcelain SAH **(e)** with and **(f)** without dynamic loading.

3 were fixed to the implants with 32 Ncm of force using a manual torque meter (Conexão Sistema de Prótese) and the SAHs were kept open. Aging was performed on five crowns in each group (half of each group) by subjecting them to dynamic loading (1,200,000 \times 100 N \times 2 Hz) before exposure to an axial compression (500 Kgf \times 0.5 mm/min) (Kratos). The load was applied by a 6-mm rod positioned vertically at the central fossa of the occlusal surface, making contact with both the buccal and lingual cusps. Statistical analysis was performed using two-way analysis of variance and the Tukey test.

Results

No specimen fractured during the cyclic load test. Significant differences were noted between group 1 and groups 2 and 3) ($P \le .05$). However, there were no statistically significant differences between groups 2 and 3, despite the numerical difference ($P \le .05$) (Table 1 and Fig 2). Although the fracture resistance values for porcelain were the same with and without dynamic loading, the screw-retained specimens that did not undergo dynamic loading suffered small fractures of the buccal cusps reaching the proximal aspect while

dynamically loaded screw-retained specimens had fractures across the buccal aspect in the mesiodistal direction (Fig 3).

Discussion

Long-term clinical trials have shown that porcelain fracture in metal-ceramic crowns over implants is a relevant factor regarding treatment failure.³ In the present study, it was observed that the cement-retained crowns presented the highest porcelain fracture resistance. The presence of an SAH is itself an aggravation of the fracture resistance of the restorative material. In such, the porcelain of cemented crowns tends to have increased resistance due to the integrity of its surfaces.^{1,3,4} The SAHs of the screw-retained prostheses were kept open so as not to mask the real influence of the framework design on the final resistance of the porcelain.⁵

Although cemented crowns have shown higher values than screwed crowns, all groups presented acceptable levels of fracture resistance for a good clinical performance. The findings that dynamic loading did not alter resistance might be attributed to the fact that metal-ceramic crowns do not allow large damage accumulation, but the fracture mode showed that dynamic loading could damage the crowns in some way. Clinically, the absence of metal may improve the esthetic results, maintaining the reversibility of screwretained crowns.

Conclusions

Occlusal discontinuation on the crowns jeopardized their resistance. Cement-retained crowns were more resistant to fracture that screw-retained ones. Among the screw-retained crowns, there were no differences between the metal and porcelain support under the SAH. Thus, it can be removed for esthetic reasons without loss of resistance to fracture. Consequently, the null hypothesis was partially accepted.

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Literature Abstract

Characterizing traditionally defined periodontal disease in HIV+ adults

This study aimed to provide a more comprehensive view of periodontal disease in human immunodeficiency virus positive (HIV+) patients under highly active antiretroviral therapy (HAART). One hundred twelve adult subjects were recruited from three outpatient HIV medical clinics in Cleveland, Ohio. Most participants were self-referred. Exclusion criteria included evidence of cardiovascular disease, a history of type I or II diabetes mellitus, fewer than 20 teeth, uncontrolled systemic illnesses, diagnosis or treatment of cancer in the past 5 years, pregnancy, and need for antibiotic prophylaxis prior to dental care, as per the current American Dental Association and other guidelines. Inclusion criteria were medication compliant adult subjects (age 18 and over) on HAART or about to start HAART within 2 months of their baseline visit. Three separate thresholds were used to define periodontal disease: periodontal probing depth (PPD) \ge 5 mm, recession (REC) > 0 mm, and clinical attachment level (CAL) \ge 4 mm. Each subject had on average of 38% (\pm 24%) of their teeth with at least one site of PPD \ge 5 mm, 55% (\pm 31%) of their teeth with at least one site of REC > 0 mm, and 50% (\pm 32%) of their teeth with at least one site of CAL \ge 4 mm. Factors associated with high levels of periodontal disease in this cohort, as measured by CAL, were immunosupression (ie, CD4+ T cell counts < 200 cells/mm³), the level of *Porphyromonas gingivalis* DNA and total DNA in subgingival plaque, substandard utilization of dental care, cigarette smoking, and older age. In this cohort, lowered CD4+ T cell counts (< 200 cells/mm³) had approximately twice the effect on periodontal disease as did cigarette smoking. Having an annual dental visit remained an independent predictor for lower levels of periodontal disease.

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