Combined Effects of Thermocycling and Load-Cycling on Microleakage of Computer-Aided Design/Computer-Assisted Manufacture Molar Crowns

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This study evaluated the combined effects of thermocycling and compressive load-cycling on microleakage of computer-aided design/computer-assisted manufacture molar crowns. Sixteen ceramic (Vita Mark-II) and 16 composite resin (Paradigm MZ-100) crowns were milled using the CEREC 3D system. Eight crowns of each group were cemented to prepared molars using Panavia F 2.0, and 8 were cemented using RelyX Unicem Clicker. Specimens were thermocycled for 500 cycles and subjected to load-cycling for 1,000,000 cycles (60 to 600 N). Specimens were then tested for microleakage. Data were analyzed statistically using the Tukey post hoc test. All composite resin crowns survived load and thermal fatigue, while 6 ceramic crowns developed cracks. There were no statistically significant differences among groups regarding microleakage scores. Paradigm MZ-100 crowns were more crack-resistant to combined load and thermal fatigue than those composed to Vita Mark-II. However, microleakage scores of both types of crowns were similar. *Int J Prosthodont 2011;24:376–378.*

The introduction of computer-aided design/computer-assisted manufacture (CAD/CAM) technology in dentistry has enabled dentists to use new treatment modalities in restorative dentistry. This technology was further developed for fabrication of monolithic ceramic and composite resin crowns.[1] The aim of this study was to evaluate the combined effects of thermo- and load-cycling on microleakage of molar ceramic and composite resin crowns fabricated using CEREC 3D (Sirona) and cemented with two adhesive resin cements.

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Materials and Methods

Thirty-two caries-free extracted molars were sterilized with gamma irradiation (2.5 mRad) for 20.5 hours (Gammacell 220, Atomic Energy) and assigned to one of four groups (n = 8 in each group) according to type and size. Each molar was prepared to receive a crown as recommended by the CEREC 3D system (1.2-mm axial reduction, cuspal reduction of 2 mm and 1.5 mm for functional and nonfunctional cusps, respectively). The central fissure area was reduced by 1.5 mm, and the gingival margin had a 1-mm-wide circumferential shoulder occlusal to the cementoenamel junction. All line angles were rounded, and the angle of convergence was maintained at 6 to 8 degrees with the aid of a parallelometer (Parallel-A-Prep, Dentatus) as well as diamond burs. The CEREC 3D system was used to construct crowns from both ceramic (Vita Mark-II, Vita Zahnfabrik) and composite resin (Paradigm MZ-100, 3M ESPE) with the same thickness. The block size was 14 mm and the shade used was A3.5. Milled crowns were polished, and thicknesses were verified using

Table 1 Microleakage Scores* of Ceramic and Composite Crowns

Group	N	Mean	SD
Composite resin crown, Panavia F 2.0 cement	8	4.0	0.0
Composite resin crown, RelyX Unicem Clicker cement	8	4.0	0.0
Ceramic crown, Panavia F 2.0 cement	8	2.8	1.2
Ceramic crown, RelyX Unicem Clicker cement	8	3.3	1.0

*0 = no microleakage, 4 = maximum microleakage.

digital calipers to ensure consistent dimensions. Any crown that showed more than a 150-μm marginal gap was discarded and replaced with a new one.

One subgroup of 8 composite resin crowns and one of 8 ceramic crowns were cemented using Panavia F 2.0 self-etching resin cement (Kuraray), while crowns of the remaining two subgroups were cemented using RelyX Unicem Clicker self-adhesive resin cement (3M ESPE). Light curing from all aspects followed, and specimens were stored in water at 37°C for 1 week. Specimens were then subjected to thermocycling in water baths for 500 cycles (30 s in 5°C, 15 s in 25°C, 30 s in 55°C). Compressive cyclic loading along the long axis followed with a 3.0-mm-diameter hardened steel ball at the central fossa using a standardized testing machine (Instron). One million load cycles of 60 to 600 N each at 12 Hz were applied per specimen under distilled water at room temperature. After cyclic loading was completed, crowns were examined under magnification for cracks or chipping.

Crowns were then subjected to microleakage testing by immersion in a 0.5% aqueous solution of red basic fuchsin dye for 24 hours after sealing the roots with nail varnish. Specimens were then rinsed in water and sectioned mesiodistally using an Isomet low-speed saw (Buehler). Images of tooth sections were captured using a digital camera, and a five-point scale was used for microleakage scoring at the mesial and distal aspects of each section as follows: 0 = no leakage, 1 = microleakage up to one third of the axial wall, 2 = microleakage up to two thirds of the axial wall, 3 = microleakage along the full length of the axial wall, and 4 = microleakage extending onto the occlusal surface.

Microleakage scores were analyzed using a statistics software program (SPSS version 13.0, IBM). Factorial analysis of variance, one-way analysis of variance, and the Tukey post hoc test were used. All tests were performed at an alpha level of .05, where $P \leq .05$ was considered significant.

Results

All Paradigm MZ-100 crowns (n = 16) survived thermocycling and cyclic loading without undergoing any chipping or fractures or developing cracks, while 3 of 8 Vita Mark-II crowns cemented with RelyX Unicem Clicker and 3 of 8 Vita Mark-II crowns cemented with Panavia F 2.0 developed surface cracks that extended from the loading point to the axial walls of the crowns. However, statistical analyses revealed no significant differences in mean microleakage scores among the four subgroups ($P > .05$, Table 1). Microleakage was detected at the dentin-resin interface only.

Discussion

The better performance of the composite resin crowns compared to the ceramic ones might be attributed to the difference in their elastic moduli. The modulus of elasticity of Vita Mark-II ceramic blocks was reported to be three times that of Paradigm MZ-100 composite.[2,3] Therefore, during cyclic loading, the composite crowns better resisted the applied load because of their higher resilience compared to the ceramic crowns. Also, both resin cements had elastic moduli values that more closely matched those of both dentin and composite blocks, but not that of the ceramic blocks.[2–4] Thus, the variance in elastic moduli of the resin cements and that of the ceramic crowns might have created higher stresses at the ceramic-cement interface, with subsequent adverse effects on the bonding between them. This, in turn, may have jeopardized the support that ceramic crowns received from the underlying tooth structure and, as a result, caused some of them to develop surface cracks.

Because forces applied during cyclic loading were uniaxial (vertical), since lateral (sliding) forces could not be reproduced, the clinical implications of the results of this study should be interpreted with caution. Also, under the oral environment conditions that crowns are subjected to, a number of multifactorial challenges could be present, including thermal and pH fluctuations, enzymatic attack, and occlusal stresses applied in various directions. These conditions are at present difficult to reproduce collectively under conditions of in vitro testing.

Conclusions

- Molar crowns fabricated using CEREC composite resin blocks (Paradigm MZ-100) resisted combined thermo- and load-cycling without failure, while 37.5% of ceramic crowns composed of Vita Mark-II blocks developed cracks.
- Microleakage scores of CEREC molar crowns were high and were not significantly different when either Panavia F 2.0 or RelyX Unicem Clicker cements were used, irrespective of crown material.

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Literature Abstract

Risk factors for onset of chronic oro-facial pain—Results of the North Cheshire Oro-facial Pain Prospective Population Study

The aim of this prospective study was to test the hypothesis that self-reported mechanical factors would predict the onset of chronic orofacial pain (COFP) and that any observed relationship would be independent of the confounding effects of psychosocial factors and reporting of other unexplained symptoms. A baseline questionnaire was mailed to 4,200 subjects aged 18 to 75. Of those, 2,505 returned the completed questionnaire at baseline; 1,735 subjects were followed-up with 24 months later with a second questionnaire. COFP was defined as pain in the face, mouth, or jaws that had been present for 1 day or longer in the past month, and such pain must have been present for at least 3 months. Subjects were defined as having newly onset COFP if they were free of COFP at baseline and reported COFP in the follow-up study. Of the putative risk factors measured, univariate analysis showed that reported grinding, anxiety, depression, health anxiety, reporting of other somatic symptoms, chronic widespread pain, and irritable bowel syndrome were significantly associated with new onset of COFP. The factors that remained in the final model, showing strongest predictors of COFP at the 2-year follow-up, were chronic widespread pain, health anxiety, and age. This study showed that of the self-reported mechanical factors examined, self-reported grinding and facial trauma were found to predict the onset of COFP. However, any risks associated with these factors were confounded by reported health anxiety and chronic widespread pain. These, along with younger age, were the strongest predictors of the onset of COFP. This prospective study allowed the separation of temporal relationships between these factors and the onset of COFP and allowed the control for potential confounding factors using a multivariate model. The findings of this study support the hypothesis that psychosocial factors are markers for the onset of COFP. The authors suggest that early psychologic management of COFP to address these factors should be the focus of future investigations.

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