Fracture Load of Implant-Supported Zirconia All-Ceramic Crowns Luted with Various Cements

Hyun-Pil Lim, DDS, PhD[a]/Jeong-Min Yoo, DDS, MSD[b]/Sang-Won Park, DDS, PhD[c]/
Hong-So Yang, DDS, PhD[d]

This study compared the fracture load and failure types of implant-supported zirconia all-ceramic crowns cemented with various luting agents. The ceramic frameworks were fabricated from a presintered yttria-stabilized zirconium dioxide block using computer-aided design/computer-assisted manufacturing technology, and were then veneered with feldspathic porcelain. Three luting agents were used. Composite resin cement (1,560.78 ± 39.43 N) showed the highest mean fracture load, followed by acrylic/urethane cement (1,116.20 ± 77.32 N) and zinc oxide eugenol cement (741.21 ± 41.95 N) ($P < .05$). The types of failure varied between groups. *Int J Prosthodont 2010;23:361–363.*

Implant-supported all-ceramic restorations are one of the best choices for improving esthetics. However, choosing the appropriate dental cement for this type of restoration is a challenge. It has been suggested that all-ceramic restorations should be bonded with adhesive resin cements to improve their fracture resistance.[1,2] On the other hand, provisional luting agents are recommended for the cementation of implant-supported restorations.[3] Previous studies examined the fracture strength of zirconia all-ceramic restorations on natural teeth using a variety of luting agents.[2,4] However, in the case of implant-supported all-ceramic restorations, there is limited information available on the type of cement. This study investigated the fracture load and failure types of implant-supported zirconia all-ceramic crowns cemented with various luting agents.

[a]*Full-Time Lecturer, Department of Prosthodontics, School of Dentistry, Chonnam National University, Gwangju, Korea.*
[b]*Graduate Student, Department of Prosthodontics, School of Dentistry, Chonnam National University, Gwangju, Korea.*
[c]*Associate Professor, Department of Prosthodontics, School of Dentistry, Chonnam National University, Gwangju, Korea.*
[d]*Professor and Chairman, Department of Prosthodontics, School of Dentistry, Chonnam National University, Gwangju, Korea.*

Correspondence to: *Dr Hong-So Yang, Department of Prosthodontics, School of Dentistry, Chonnam National University, Yongbong-ro 77, Bukgu, Gwanju 500-757, Korea. Fax: (82) 62-530-5639. Email: yhsdent@chonnam.ac.kr*

Materials and Methods

Twenty-four abutments (Cemented abutment CAR535C, Osstem) were connected to implant analogs (FAR300, Osstem). The abutment-analog complexes were tightened to 35 Ncm and embedded in specimen holders perpendicular to the horizontal plane using autopolymerizing acrylic resin (Duralay, Reliance).

Ceramic frameworks of the mandibular first premolar were fabricated from a presintered yttria-stabilized zirconium dioxide block using computer-aided design/computer-assisted manufacturing technology (Everest ZS blank, KaVo). Each core had a thickness of 0.3 mm and a cement gap of 0.03 mm. After milling, the green bodies were sintered at 1,450°C for 8 hours. All copings were veneered (cusp tips and proximal contact points: 1.5 mm, central fossa: 1.2 mm, margin: 1.0 mm) and then glazed with feldspathic porcelain (Cerabien, Noritake). The thickness of the core and crown were regulated carefully and checked with calipers throughout the procedure.

The 24 crowns and corresponding abutment-analog complexes were divided randomly into three groups (n = 8) and assigned to one of the following cement groups: zinc oxide eugenol cement (TempBond, Kerr), acrylic/urethane cement (Premier Implant Cement, Premier), and composite resin cement (RelyX Unicem, 3M ESPE) (Table 1).

Table 1 Materials Used in This Study

Brand name	Composition	Manufacturer
TempBond (zinc oxide eugenol cement)	Zinc oxide, eugenol	Kerr
Premier Implant Cement (acrylic/urethane cement)	Triethylenglycoldimethacrylate, 2-hydroxyethylmethacrylate, aliphatic urethane diacrylate resilient oligomer	Premier
RelyX Unicem (composite resin cement)	Filler (72%), dimethacrylates, methacrylated phosphoric ester	3M ESPE

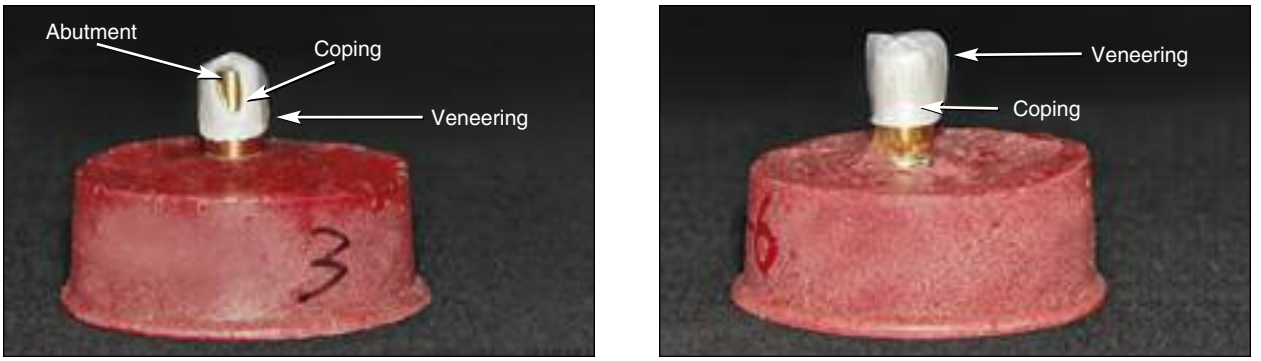

Fig 1 Failure types of the representative fractured specimens after loading. **(left)** Mixed fracture; **(right)** veneering fracture.

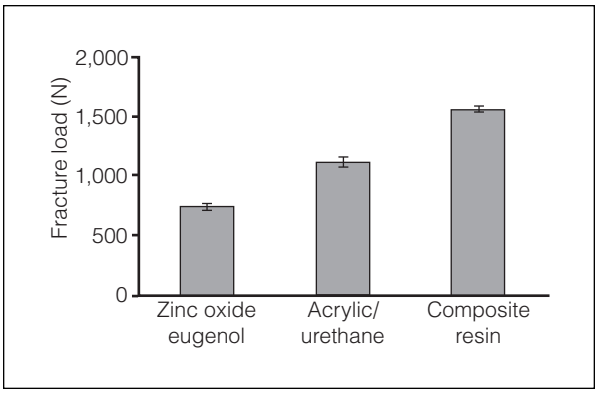

Fig 2 (left) Mean (± standard deviation) fracture load values for the experimental groups.

The all-ceramic crown-abutment assemblies were exposed to 100,000 cycles of a mechanical load in a masticatory simulator. A load of 50 N was applied to the buccal cusp at a frequency of 1.3 Hz using a 4-mm-diameter ball. All specimens were subjected to 15,000 cycles of thermocycling between 5°C and 55°C for 10 seconds each, with an intermediate pause of 5 seconds.

Fracture tests were carried out using a universal testing machine at a constant crosshead speed of 0.1 µm/min. The compressive load (N) was centered on the central fossa of each crown, and the maximum load at failure was recorded for each specimen. The failure types were analyzed after the fracture load tests. The failure types were classified as either mixed fracture (zirconia coping fracture including a porcelain veneering layer fracture) or veneering fracture (fracture between layering porcelain and zirconia coping without zirconia core fracture) (Fig 1).

Data were analyzed using one-way analysis of variance (ANOVA) and the Tukey multiple comparison test. Statistical analysis was performed using SPSS version 12.00 (SPSS).

Results

Zinc oxide eugenol cement, acrylic/urethane cement, and composite resin cement had mean fracture loads of 741.21 ± 41.95 N, 1,116.20 ± 77.32 N, and 1,560.78 ± 39.43 N, respectively (Fig 2). One-way ANOVA showed that the type of cement had a significant influence on the fracture load values ($P < .05$). The between-group comparisons were significant according to the Tukey multiple comparison test ($P < .05$). All zinc oxide eugenol cement specimens exhibited fracture from the luting cement layer to the zirconia all-ceramic crown (mixed fracture), but the composite

resin cement specimens showed fracture at the interface between the luting cement and the zirconia core and in the zirconia all-ceramic crown (Table 2).

Discussion

The elastic modulus of the cements and their susceptibility to thermocycling may affect the fracture load under the experimental conditions of this study. The fracture resistance of monolithic ceramic restorations increased with increasing elastic modulus of the supporting substrate.[5] The elastic modulus of TempBond, Premier Implant Cement, and Rely X Unicem were 0.22, 1.50, and 7.8 to 8.9 GPa, respectively.[6,7] Zirconia coping fracture appears to be the result of the low elastic modulus and high displacement of the zinc oxide eugenol cement. However, the high elastic modulus and low displacement of the composite resin cement seems to inhibit zirconia coping fracture.

Conclusions

The type of cement had a significant effect on the fracture load of implant-supported zirconia all-ceramic crowns.

The fracture load of implant-supported zirconia all-ceramic crowns was highest with composite resin cement and lowest with zinc oxide cement.

In terms of failure type, all specimens in the zinc oxide cement group exhibited zirconia coping fracture.

Table 2 Distribution of the Failure Types for Each Study Group

	Mixed fracture (%)	Veneering fracture (%)
Zinc oxide eugenol	100.0	-
Acrylic/urethane	62.5	37.5
Composite resin	50.0	50.0

References

1. Burke FJ. The effect of variations in bonding procedure on fracture resistance of dentin-bonded all-ceramic crowns. Quintessence Int 1995;26:293–300.
2. Komine F, Tomic M, Gerds T, Stub JR. Influence of different adhesive resin cements on the fracture strength of aluminum oxide ceramic posterior crowns. J Prosthet Dent 2004;92:359–364.
3. Pan YH, Lin CK. The effect of luting agents on the retention of dental implant-supported crowns. Chang Gung Med J 2005;28: 403–410.
4. McCormick JT, Rowland W, Shillingburg HT Jr, Duncanson MG Jr. Effect of luting media on the compressive strengths of two types of all-ceramic crown. Quintessence Int 1993;24:405–408.
5. Wakabayashi N, Anusavice KJ. Crack initiation modes in bilayered alumina/porcelain disks as a function of core/veneer thickness ratio and supporting substrate stiffness. J Dent Res 2000;79:1398–1404.
6. Powers JM, Sakaguchi RL. Craig's Restorative Dental Materials, ed 12. St Louis: Mosby, 2006:482.
7. Saskalauskaite E, Tam LE, McComb D. Flexural strength, elastic modulus, and pH profile of self-etch resin luting cements. J Prosthodont 2008;17:262–268.

Literature Abstract

Oral *Candida* infection and colonization in solid organ transplant recipients

It has been reported that transplant recipients are more susceptible to *Candida* infection of the oropharynx. This study looked into the prevalence of oropharyngeal candidiasis, the oral carrier status, *Candida* titers, and species in this patient group. Over 1 year postoperative, medically stable kidney and heart transplant individuals (n = 90) and age-matched healthy controls (n = 72) were involved in this study. Oral mucosa swabs and a standardized amount of saliva were plated on a culture media. Sizes of the colony-forming units were calculated. Speciation was determined based on color and was confirmed by standard germ tube, biotyping, or polymerase chain reaction assays. Results indicated that: *(1)* over the study period, 7 transplant individuals were infected with *C albicans*, none in the control group; *(2)* significantly higher *Candida* titers were noted in the transplant group; *(3)* no statistically significant relationships were established between the usage of of immunosuppressants and *Candida* titers or infection; *(4)* when compared with the control group, a significantly higher percentage of transplant subjects were colonized by more than one *Candida* species; *(5)* the most commonly found *Candida* species combination in transplant subjects was *C albicans* and *C glabrata*; and *(6) C glabrata* was found in 13.5% of transplant carriers, none in the control group. The authors concluded that oral *Candida* infection and titers were higher in the transplant group. Although the majority of transplant patients were colonized by *C albicans*, *C glabrata* was the second most commonly found species. In this study, infection was described as "clinical and microbiologic evidence of erythematous candidiasis on the dorsum of the tongue or hard palate, occasionally accompanied by a mild burning sensation." It would be interesting to see the significance of these infections with respect to the long-term outcomes of transplant patients.

Dongari-Bagtzoglou A, Dwivedi P, Ioannidou E, Shaqman M, Hull D, Burleson. *J Oral Microbiol Immunol* 2009;24:249–254. **References:** 46.
Reprints: Anna Dongari-Bagtzoglou, 263 Farmington Avenue, Farmington, CT 06030. Email: adongari@uchc.edu—*Ansgar C. Cheng*