Effect of an Occlusal Screw-Access Hole on the Fracture Resistance of Permanently Cemented Implant Crowns: A Laboratory Study

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This study aimed to evaluate the fracture resistance of cement-retained metal-ceramic implant-supported posterior crowns. Three groups of 10 restorations each were tested: group A (cement-retained using zinc phosphate), group B (cement-retained using zinc oxide–eugenol), and group C (cement-retained using zinc phosphate but with an occlusal screw-access hole). All specimens were thermocycled and vertically loaded in a universal testing machine. Mean values of fracture loads were calculated and analyzed statistically. The cement-retained restorations without an occlusal screw-access hole showed significantly higher mean fracture loads than those having one. The type of cement did not affect the porcelain fracture resistance significantly. *Int J Prosthodont 2011;24:267–269.*

From a clinical point of view, the mechanical resistance of implant-supported restorations is considered to be an important factor affecting the long-term success of dental implants.[1] However, few quantitative data are available to compare the structural properties of various implant prosthetic components. Therefore, this ex vivo study aimed to determine if the type of cement or the presence of an occlusal screw-access opening would affect the porcelain fracture resistance of cement-retained metal-ceramic implant-supported posterior crowns.

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Materials and Methods

Biomet 3i external-hexagon implants were embedded in clear acrylic resin to carry 30 different types of mandibular molar-shaped restorations (Fig 1). The 30 restorations were divided into three groups of 10 restorations each: group A (cement-retained with zinc phosphate), group B (cement-retained with zinc oxide–eugenol), and group C (cement-retained using zinc phosphate but with an occlusal screw-access hole).

Thirty standardized custom cast abutments were fabricated using cobalt-chromium alloy (remanium 2000, Dentaurum JP) and 30 metal copings were fabricated as wax-ups directly on the abutments and cast in the same alloy. Subsequently, porcelain (VITA VM 13, Vident) was built up according to the manufacturer's recommendations.

The dimensions of the crowns in the three groups were as follows: The buccolingual dimension was in the range of 10.7 to 11.0 mm, the mesiodistal dimension was in the range of 11.9 to 12.1 mm, and the occluso-cervical dimension was in the range of 8.4 to 8.7 mm.

After the abutments were secured to their corresponding implants and the crowns were cemented to their abutments, all specimens were thermocycled between 5°C and 65°C for 30 seconds each, with an intermediate pause of 12 seconds for 510 cycles, and then subjected to a vertical compression load with a universal testing machine (Model 1195, Instron). A 6-mm-diameter ball was used to apply a vertical static

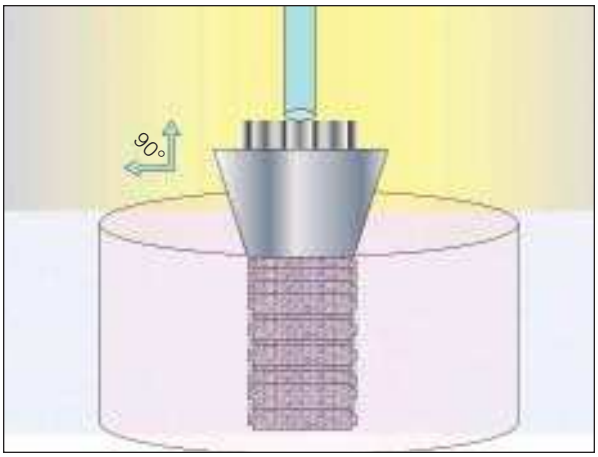

Fig 1 Implant mounted in a clear acrylic resin block.

Fig 2 Frontal view of the loading apparatus.

Table 1 Porcelain Fracture Pattern as Seen from Frontal and Occlusal Views and the Number of Cervical Fractures

Group	Frontal view	Occlusal view	Cervical fracture
A and B	The fracture of porcelain extended from the loading point to the middle third, involving only one axial surface of the crown	Area of fracture comprised less than one quarter the circumference of the crown	Small cervical notching (n = 1)
C	The fracture of porcelain extended from the loading point to the junction between the middle and cervical thirds, involving more than one axial surface	Area of fracture comprised one quarter or more of the circumference of the crown	Cervical fracture (n = 3)

compressive load at the central portion of the restoration at a cross-head speed of 2 mm/min (Fig 2). The screw-access holes of group C were left unfilled because no uniform guidelines currently exist regarding what material should be used.

Mean values for all groups were calculated and compared using one-way analysis of variance (ANOVA) and the Tukey post hoc test. Statistical significance was set at $\alpha = .05$.

Results

The highest mean fracture resistance value occurred in group A (3,707 ± 1,086 N), followed by group B (3,169 ± 867 N) and group C (1,700 ± 526 N).

The one-way ANOVA test identified that a significant difference existed among the three groups. The Tukey post hoc test showed that groups A and B exhibited significantly higher fracture strength than group C. However, comparing groups A and B, no significant difference was noted.

Regarding the fracture patterns, no screw bending, screw fracture, or implant neck distortion was observed in any test specimen, and all failures took the form of porcelain fracture. The porcelain fracture patterns are outlined in Table 1.

Discussion

To the best of the authors' knowledge, this is the first study conducted to examine the influence of different types of luting agents on the fracture strength of metal-ceramic implant-supported crowns. The results of this study showed that there is no significant difference in mean fracture resistance values between the crowns cemented with zinc phosphate and those cemented with zinc oxide–eugenol. This result supports the conclusion of a finite element analysis that showed that the cement layer does not play a significant role in resisting deflection from an axially applied force on metal-ceramic crowns.[2]

It has been assumed that the screw-access hole in screw-retained restorations can weaken the porcelain around the hole and at the cusp tips, resulting in porcelain fracture. The present study supported this assumption and found that the presence of a screw-access hole in the occlusal surface of the cemented crowns significantly decreased the fracture strength of the porcelain.

Although no comparison data are available in the literature regarding the fracture strength of cement-retained implant-supported restorations with an occlusal screw-access hole, the findings of this study

support the results of Torrado et al,[3] Zarone et al,[4] and Karl et al,[5] who found that cement-retained restorations with an intact occlusal surface showed a higher porcelain fracture resistance than screw-retained ones.

The primary limitation of this study was that the specimens were loaded to failure in a single cycle, even though restorations may fail clinically through slow crack growth caused by fatigue loading. In addition, leaving the screw-access openings unfilled may be considered a further limitation. Also, it would be preferable to add a fourth group with an occlusal screw-access hole using zinc oxide–eugenol cement, which is used more clinically than zinc phosphate in implant dentistry. However, since the intact crowns cemented with zinc oxide–eugenol were insignificantly weaker than those cemented with zinc phosphate, it can be inferred that the same would be applied to crowns with a screw-access hole using the two types of cements. Future research in this area should concentrate on the testing of crowns under physiologic fatigue loading using different types of provisional and permanent cements.

Conclusions

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

- Cement-retained restorations without an occlusal screw-access hole showed significantly higher mean fracture loads of the veneering porcelain than those with an occlusal screw-access hole, irrespective of the type of cement.
- Cementing the restorations with either zinc phosphate or zinc oxide–eugenol did not affect the porcelain fracture resistance significantly.

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Literature Abstract

Alveolar ridge augmentation using implants coated with recombinant human growth/differentiation factor-5: Histologic observations

In vitro and in vivo preclinical studies suggest that growth/differentiation factor-5 (GDF-5) may induce local bone formation. The objective of this study was to evaluate the potential of a recombinant human GDF-5 (rhGDF-5)–coated oral implant with a purpose-designed titanium porous oxide surface to stimulate local bone formation, including osseointegration and vertical augmentation of the alveolar ridge. Bilateral, critical-size, 5-mm supraalveolar peri-implant defects were created in 12 young adult Hound/Labrador mongrel dogs. Six dogs received implants coated with 30 or 60 mg rhGDF-5, and 6 received implants coated with 120 mg rhGDF-5 or were left uncoated (control). The animals received fluorescent bone markers at weeks 3, 4, 7, and 8 postsurgery, when they were euthanized for histologic evaluation. There were no noteworthy differences between implants coated with rhGDF-5. There was a small increase in induced bone height for implants coated with rhGDF-5 compared with the control: induced bone height averaging 1.6 ± 0.6 mm for implants coated with 120 mg rhGDF-5 versus 1.2 ± 0.5, 1.2 ± 0.6, and 0.6 ± 0.2 mm for implants coated with 60 mg rhGDF-5, 30 mg rhGDF-5, or left uncoated, respectively ($P < .05$). Bone formation was predominant at the lingual aspect of the implants. Narrow yellow and orange fluorescent markers throughout the newly formed bone indicate relatively slow new bone formation within 3 to 4 weeks. Implants coated with rhGDF-5 displayed limited peri-implant bone remodeling in the resident bone; the 120-mg dose exhibited more advanced remodeling than the 60- and 30-mg doses. All treatment groups exhibited clinically relevant osseointegration.

Polimeni G, Wikesjö UME, Susin C, et al. *J Clin Periodontol* 2010;37:759–768. **References:** 40. **Reprints:** Giuseppe Polimeni, Laboratory for Applied Periodontal & Craniofacial Regeneration, Department of Periodontics & Oral Biology, Medical College of Georgia School of Dentistry #AD1430, 1120 Fifteenth Street AD-1434, Augusta, GA 30912, USA. Email: gpolimeni@hotmail.com—*Tee-Khin Neo, Singapore*