Reliability of abutments veneered with indirect composite for implant-supported crowns

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Objectives: To investigate the reliability/failure modes of different supporting size abutments veneered with indirect composites for implant-supported crowns.

Methods: Regular size abutments (R) (6.35 mm diameter base, with a 4 mm high and 2 mm diameter post in the center for composite retention), small (S) (5.2 mm base, 4 mm high and 2 mm diameter post), and small with post shortened (SS) to 2 mm height titanium abutments (Fig. 1) (Bicon LLC, Boston, USA,) received incremental layers of indirect resin composite (Ceramage, Shofu, Japan) until complete the anatomy of a molar crown (Fig. 2). Three crowns of each material were loaded until failure for determination of step-stress profiles for accelerated-life fatigue testing (n=18 each). Weibull curves with use-stress of 200N for 50K cycles (90% confidence intervals) were calculated and plotted using a power law relationship for damage accumulation. Weibull modulus "Beta" and characteristic strength "Eta" were identified and a contour plot was used (Beta vs. Eta) for examining differences between groups. Specimens were inspected in light and scanning electron microscope.

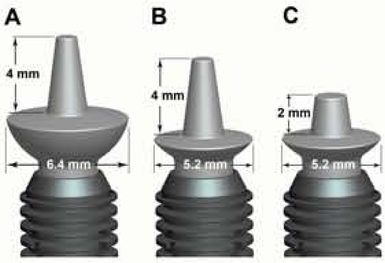

Fig. 1) Abutment configurations tested: A) R, B) S, and C) SS.

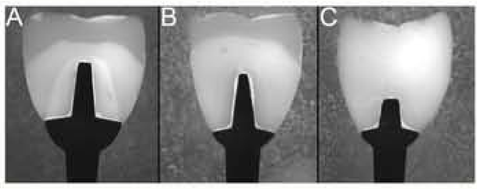

Fig. 2) Crowns sectioned in the buccal-lingual direction showing indirect resin supported by the abutments of A) R, B) S, and C) SS groups.

Results: Beta values were 0.27 for R, 0.25 for S, and 0.26 for SS abutments, indicating that failures were not influenced by fatigue and damage accumulation, whereas strength was the main factor dictating failure of groups (Fig. 3). The data was replotted as Weibull distribution and the characteristic strengths of 796 N and 832 N for R and S abutments, respectively, were not significantly different (confidence bounds overlap, p > .10), but significantly higher than 588 N for SS (Fig. 4). Reliability data is presented in Table 1. Failure mode was cohesive within the composite for R and S, and mixed cohesive and crown debond from abutment for SS (Fig. 5).

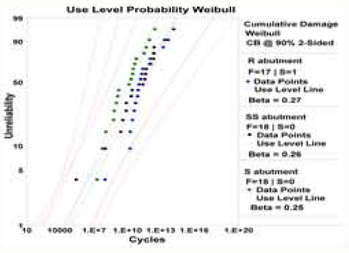

Fig. 3) Unreliability versus cycles plot (90% 2-sided confidence bounds) at a 200 N use stress for R, S, and SS groups.

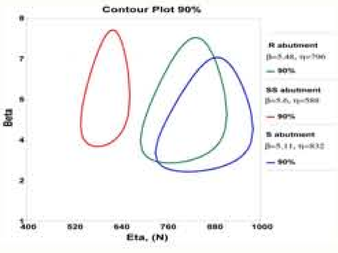

Fig. 4) Probability Weibull contour plot (Beta VS Eta) for the different abutment configurations. Note that the significantly lower characteristic strength (Eta) observed for SS when compared to R and S is graphically seen as the non overlap of this group with the others.

Mission of 50 K cycles at 200 N

	R	S	SS
Upper limit	0.99	0.99	0.99
Reliability	**0.99**	**0.98**	**0.98**
Upper limit	0.95	0.94	0.94

Table 1. Reliability for completion of a mission of 50,000 cycles at 200 N shows no statistical differences between groups, as observed by the overlap between upper and lower limits (p>.10)

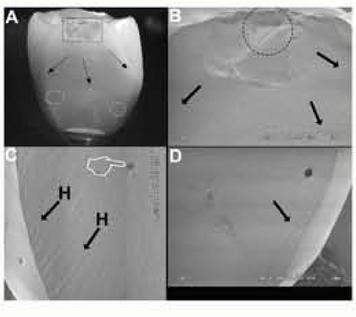

Fig. 5) Cohesive failure within the composite of a S abutment crown failed after 91,232 cycles at 800 N in the mild profile. A) Polarized light micrograph shows the extension of the fracture and the indentation area (dashed rectangle) as the fracture origin. Note that a small area of the base of the titanium abutment was exposed. Fracture propagated towards the margins of cohesively failed composite (dotted arrows), leaving fractographic marks observed in detail in B, where the SEM magnified view shows in greater detail the indentation area (dashed circle) and the direction of crack propagation (arrows). SEM micrographs C and D are magnified views of left and right dashed white circles shown in A, respectively, where hackles (H, arrows) and wake hackles (pointer) portray crack front direction.

Conclusion: Realibility for a mission of 50 K cycles at 200 N was not significantly different between different abutment designs. Failure modes differed.

REFERENCES

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2) Quinn JB, Quinn GD. Material properties and fractography of an indirect dental resin composite. Dent Mater 2010; 26:589-99.