Fracture Resistance of CAD/CAM-Fabricated Fiber-Reinforced Composite Denture Retainers

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The purpose of this study was to evaluate the fracture resistance of computer-aided design/computer-assisted manufacture (CAD/CAM)-fabricated fiber-reinforced composite (FRC) denture retainers. Distal extension dentures incorporating two telescopic retainers and two molar pontics, with or without fiberglass, were fabricated by CAD/CAM or by the conventional polymerization method. The dentures were subjected to a vertical load on the second molar pontic until fracture. Within each manufacturing method, embedment of the FRC increased the mean final fracture load, suggesting the reinforcing effect of fiberglass. The polymerized dentures with FRC showed greater mean final fracture load than the CAD/CAM dentures with FRC. *Int J Prosthodont 2013;26:381–383. doi: 10.11607/ijp.3415*

Fiberglass-reinforced composite (FRC) has high strength and the potential to be used for telescopic retainers for computer-aided design/computer-assisted manufacture (CAD/CAM) conventional and implant-supported dentures.[1–3] The purpose of this study was to assess the effect of fiberglass alignment on fracture resistance of composite resin retainers.

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Materials and Methods

The unilateral denture framework consisted of telescopic retainers for two premolar abutments and two molar pontics for the distal extension part. The dimensions of cone-shaped abutments included a base diameter of 5 mm and a height of 5 mm, with a convergence angle of 6 degrees. The CAD/CAM dentures were fabricated using a composite block (CAD-Temp for inLab, VITA Zahnfabrik) or an experimental composite block with fiberglass. The dentures were termed CAD-C (n = 5) and CAD-FRC (n = 5), respectively. To prepare the CAD-FRC blocks, a bundle of unidirectional fiberglass (Hybon 2002 Direct Drawn Roving, PPG Fiber Glass) was longitudinally piled throughout the entirety of the block. The configuration of each crown was programmed on the basis of the reported anatomical data.[4]

The polymerized composite dentures were prepared using a commercial composite (Z250, 3M ESPE) with and without fiberglass and were termed Po-FRC (n = 5) and Po-C (n = 5), respectively. The Po-FRC dentures incorporated three bundles of fiberglass (everStick C&B, StickTECH) (Fig 1). The dentures were photo- and heat-polymerized at 95°C for 20 minutes.

The retainers were bonded to silver-palladium-copper-gold alloy abutments with epoxy die and fixed to a universal testing machine (Fig 2). Vertical load was applied to the central occlusal surface of the second molar with a crosshead speed of 1 mm/min. The loads at the points of initial fracture (IF) and final fracture (FF) were recorded. The IF was deemed

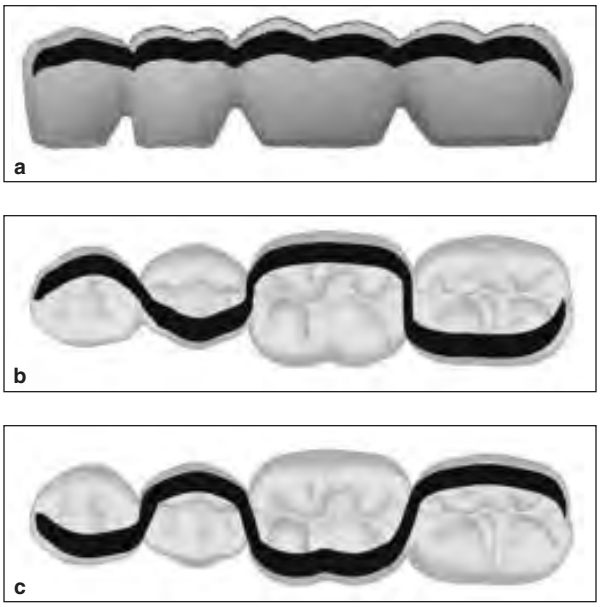

Fig 1 Schematic illustrations of the fiberglass alignment in the Po-FRC dentures. Three bundles of fiberglass were embedded in the space created between the silicone index and the master die prior to the packing of the composite resin paste. One bundle of the unidirectional fiberglass was longitudinally piled on the occlusal side **(a)**, and the others were positioned from medial to distal around the abutment, alternating between the lingual and buccal side **(b and c)**.

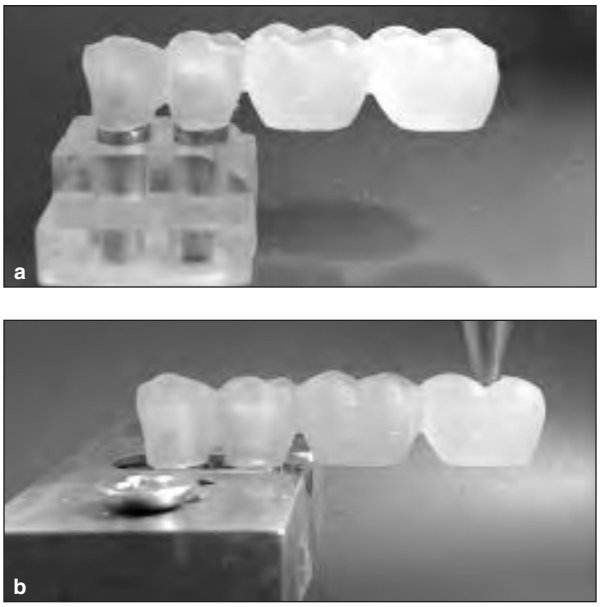

Fig 2 Fracture test. **(a)** Each retainer was bonded to the cast abutment that was placed on an epoxy base. **(b)** Each denture on the epoxy base was fixed to a universal testing machine with a clamping jig and subjected to vertical loading on the second molar pontic.

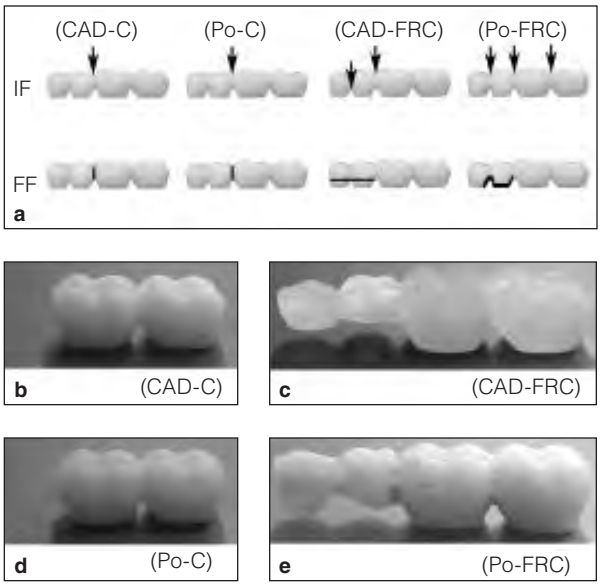

Fig 3 Fracture mode illustrations and representative fractured specimen for each group. **(a)** The site of initial fracture (IF) is indicated by a black triangle, while the final fracture (FF) is depicted by a black line. Representative fractured specimens for each group. **(b)** CAD-C; **(c)** CAD-FRC; **(d)** Po-C; and **(e)** Po-FRC.

to have occurred when a sharp decline in the load/deflection curve was detected. The FF was deemed to have occurred when any of the following events were recorded: *(1)* attainment of an instability condition, *(2)* decrease of the maximal load or displacement before the load by 50%, or *(3)* apparent catastrophic rupture.[5]

Results

All CAD-C and Po-C dentures fractured with simultaneous IF and FF (Fig 3). For the Po-FRC, the IF was evident at one of the connectors, and the FF occurred at the cervical portion of the retainer. For the CAD-FRC dentures, the IF was evident at the retainer /pontic connector or at the mesial cervical region, and the FF occurred at the cervical region with a catastrophic fracture. The mean and standard deviations of the IF and FF loads are shown in Table 1.

Discussion

A reinforcing effect of the fiberglass was evident, as the mean FF loads of the Po-FRC and the CAD-FRC were significantly greater than those of the corresponding dentures without the fiberglass. Since the

Table 1 Means (SDs) of the Initial and Final Fracture Loads

	CAD-C	Po-C	CAD-FRC	Po-FRC
IF load	22.2 (3.9)*	44.9 (4.1)**	76.4 (19.5)*	48.4 (14.7)***
FF load	22.2 (3.9)#	44.9 (4.1)#	142.0 (22.1)##	185.0 (25.2)###

SD= standard deviation; IF = initial fracture; FF = final fracture.
Mean values with different superscript symbols indicate that there was a statistically significant difference between the values in each of the IF and FF groups ($P < .05$).

CAD/CAM blocks contained fiberglass throughout their volume, the composite of the occlusal surface was filled with the fiberglass. This could create a higher initial fracture resistance for the CAD-FRC dentures compared with Po-FRC.

The lower mean FF load for the CAD-FRC dentures in comparison with that of the Po-FRC might be attributable to fiberglass intermission occurring at the stress-susceptible region of the denture. The bulk of the composite was solidly packed with fiber bundles for the Po-FRC dentures that could be manufactured without damaging the fiberglass. The fiberglass bundles bonded with composite were resistant enough to prevent the crack from spreading to the medial area.

Conclusion

The findings suggest that CAD/CAM dentures using a composite block of uniformly embedded fiberglass yield a higher resistance to initial fracture, while the polymerized composite dentures reinforced with conventional piled-up fiberglass can reduce the risk of catastrophic failure.

Acknowledgments

This study was supported by a Grant-in-Aid (no. 24592902 to NW) for research from the Japan Society for Promotion of Science/MEXT and belongs to the activity of BioCity Turku Biomaterials Research Program (www.biomaterials.utu.fi). The authors reported no conflicts of interest related to this study.

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Literature Abstract

The prevalence of dentin hypersensitivity in general dental practices

This cross-sectional study aimed to investigate the prevalence of dentin hypersensitivity in general dental practices as well as the associated risk factors. A total of 787 adult patients from 37 general dental practices within the Northwest Practice-based Research Collaborative in Evidence-basedDENTistry (PRECEDENT) were asked to complete a survey in which hypersensitivity was diagnosed through a question about the presence of pain in the teeth and gingiva. The investigators did a clinical examination to exclude other sources of pain. A visual analog scale and the Seattle Scales in response to a one-second air blast were both used to rate the pain level. Generalized estimating equation log-linear models were used to estimate the prevalence and prevalence ratios. The prevalence of dentine hypersensitivity was found to be 12.3 percent and those with hypersensitivity had an average of 3.5 hypersensitive teeth. There was increased prevalence of dentine hypersensitivity in 18 to 44 year olds, women, patients with gingival recession, and those who have done at-home tooth whitening. No association was found between dentine hypersensitivity and obvious occlusal trauma, noncarious cervical lesions, nor aggressive toothbrushing habits.

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