Short Communication

Wear Resistance of Artificial Denture Teeth

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This study aimed to evaluate the wear resistance of artificial teeth when opposed by antagonists made from the same material. The artificial teeth tested included ceramic teeth, nanofilled composite resin teeth, acrylic resin teeth, and experimental acrylic resin teeth. After 600,000 chewing cycles, the mean total vertical substance loss and mean volume loss for acrylic resin and experimental acrylic resin teeth were significantly lower than for ceramic and composite resin teeth. Composite resin teeth showed more wear than ceramic teeth, while acrylic resin teeth showed less wear than ceramic teeth. However, scanning electron microscopy and laser-scanner observations showed that acrylic resin teeth exhibited deformation at the contact surfaces. *Int J Prosthodont 2008;21:166–168.*

Excessive wear may cause loss of vertical dimension of occlusion, loss of masticatory efficiency, faulty tooth relationships, and fatigue of masticatory muscles.[1,2] The materials used for denture tooth fabrication determine the wear resistance to a great extent. The purpose of this study was to evaluate the 2-body wear resistance of artificial teeth opposed by antagonists made from the same material in a dual-axis chewing simulator.

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Materials and Methods

Four different denture teeth were tested: ceramic teeth, nanofilled composite resin teeth, acrylic resin teeth, and experimental acrylic resin teeth. For each type, 8 maxillary and 8 mandibular first premolars were prepared (Table 1). The cusps of each maxillary tooth specimen were wet abraded and polished with 2,500- and 4,000-grit abrasive paper to a depth of 0.5 mm to achieve a flat area of about 2.5 × 3.0 mm for loading during the wear test.[3] The buccal cusps of the mandibular first premolars were used as antagonistic specimens. The wear test was performed in a dual-axis chewing simulator (Willytec).[4] The weight load of each antagonistic mandibular premolar was 5 kg, and the horizontal sliding was 0.3 mm. Additionally, thermal cycling between 5°C and 55°C was performed during dynamic loading.[5] After 600,000 chewing cycles, the vertical substance loss of the mandibular premolars was measured with an optical microscope. The vertical loss and volume loss of the maxillary premolars were measured with a laser scanner.

One-way analysis of variance was used to compare the mean values. Since the Levene test showed no homogeneity of the variances, comparisons between mean values were carried out with the Games-Howell test.

For qualitative analysis of the abraded contact surfaces, the specimens were sputter-coated with gold and evaluated using a scanning electron microscope (SEM).

Table 1 Denture Teeth Tested in the Study

Product	Manufacturer	Lot no.	Color	Size	Material
Bonartic CT	Candulor	411018	J1	06	Feldspathic ceramic
Condyloform II NFC	Candulor	007672	A2	38	Nanofilled composite resin
Polystar Selection	Merz Dental	3436	A2	XL	IPN resin
Experimental resin teeth	Ivoclar Vivadent	3135	A2	N5	Acrylic resin with UDMA/PMMA

IPN = interpenetrating polymer networks; UDMA = urethane dimethacrylate; PMMA = polymethyl methacrylate.

Table 2 Vertical Substance Loss (μm) and Volume Loss (mm^3) After 600,000 Chewing Cycles*

Denture tooth	Mandibular vertical loss	Maxillary vertical loss	Total vertical loss	Maxillary volume loss
Ceramic	52 ± 12	75 ± 16	127 ± 23[b]	0.068 ± 0.028[c]
Nanofilled composite resin	68 ± 8	92 ± 11	160 ± 14[c]	0.134 ± 0.045[d]
Acrylic (IPN) resin	38 ± 8	34 ± 8	73 ± 13[a]	0.019 ± 0.004[b]
Experimental acrylic resin	36 ± 5	24 ± 3	59 ± 7[a]	0.011 ± 0.001[a]

*The same capital letter within a row means values are not statistically different at $P \leq .05$ (Games-Howell test).
IPN = interpenetrating polymer networks.

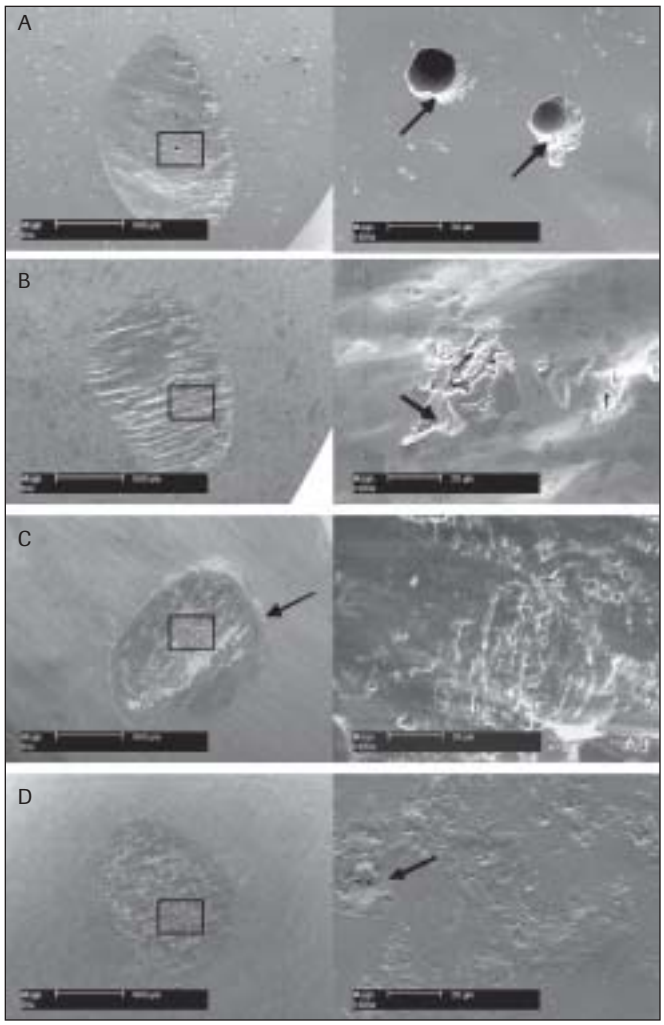

Fig 1 SEM observation of the wear surfaces of the tested teeth (*left column* shows original magnification ×50 and *right column* shows original magnification ×1,000). A = ceramic (*arrows* indicate pores); B = nanofilled composite resin (*arrow* indicates a missing filler particle); C = acrylic resin (*arrows* indicate deformation of the surface); D = experimental acrylic resin.

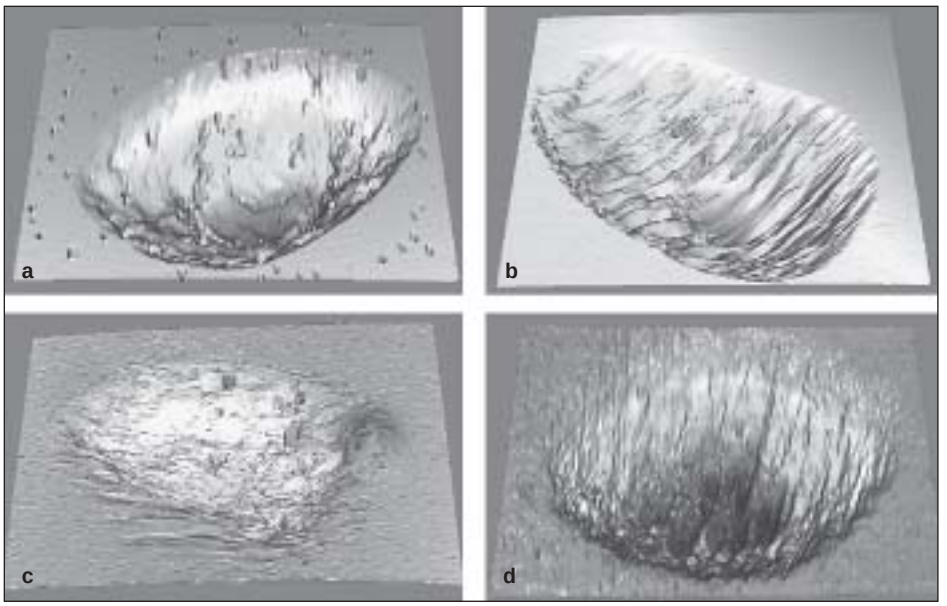

Fig 2 Laser scanner plots of the wear surfaces of the tested teeth. a = ceramic; b = nanofilled composite resin; c = acrylic resin; d = experimental acrylic resin.

Results

The statistical differences were not completely identical for the vertical substance loss and the volume loss for the tested materials (Table 2). SEM observations of the abraded surfaces showed that ceramic teeth exhibited pores that were clearly identified at a magnification of ×50, and the abraded area was smooth (Fig 1). In the composite resin teeth, some cracks were seen on the wear surface between the filler and the resin matrix, and some filler particles were missing. In contrast, the experimental acrylic resin teeth showed deformation of the surfaces, and the abraded areas were rough, but no cracks were seen on the wear surface.

Discussion

The wear test was performed via loading with the buccal cusps of mandibular premolars as antagonists, which seems to be relevant for clinical applications since this combination is usually used for complete dentures. The results of this study can be explained by the composition of the teeth. The acrylic teeth did not contain inorganic fillers, which may play an important role in the attritional wear. Moreover, the elastic modulus of the acrylic resin teeth without inorganic filler is higher than that of the composite resin teeth with inorganic fillers. Therefore, the composite resin teeth showed more wear than the acrylic resin teeth. The 3-dimensional laser scanner plots showed that the latter teeth exhibited deformation of the contact area during the wear test, whereas this phenomenon could not be observed in the composite resin or ceramic teeth (Fig 2).

Conclusions

1. Composite resin teeth demonstrated vertical substance loss and volume loss approximately 25% and 100% higher, respectively, than those of ceramic teeth when opposed by antagonists made from the same material.
2. The acrylic resin teeth showed significantly less wear than composite resin and ceramic teeth. Based on these results, acrylic resin teeth seem to be a suitable alternative to ceramic teeth for complete dentures in terms of wear resistance.

References

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