Microabrasion of Cast Metal Margins—A Warning

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Plastic test patterns were milled to simulate casting margins and were cast in a variety of dental alloys. The cast specimens were exposed to horizontal and vertical streams of low-pressure microabrasion with 50 μm aluminum oxide particles. Post-exposure measurements show all specimens were affected by microabrasion. Dentists and laboratory technicians who use microabrasion must be aware of the potential damage to casting margins.

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INDEX WORDS: sandblasting, particle abrasion, aluminum oxide, glass beads, dental materials, dental laboratory procedures, divestment, surface treatments

MICROABRASION, commonly called "sandblasting" and "particle abrasion," is often used during dental laboratory procedures involving cast metals. Microabrasion has been recommended for the removal of oxides from metallic surfaces,[1-3] preparation of internal casting surfaces for cementation,[1] removal of disclosing media used during fitting procedures,[1] removal of investment during casting recovery,[2-4] creation of deep irregularities in internal casting surfaces prior to micromechanical bonding,[1] and the preparation of metal surfaces for porcelain application.[2-5]

Microabrasion is convenient and popular. Unfortunately, proponents of microabrasion rarely describe adverse effects of this procedure or cite any metal-safety requirements, and only occasionally offer vague precautions concerning damage to "thin metal margins."[1,4] One author (MM) with 8 years of experience as the director of area dental laboratories in the military, frequently encountered irreparably damaged castings and master dies, caused by unanticipated outcomes of microabrasion use.

To investigate the damage risk to dental alloys exposed to microabrasion, test conditions were devised where cast metal margins were exposed to streams of microabrasion particles. The conditions of the tests and the metal types selected were relevant to current laboratory usage.

The tests were not designed using strict scientific methodology, but were accomplished to investigate if common dental alloys would be damaged if exposed to standard microabrasion practices. Test results per alloy will not be compared, as they are in some scientific studies. Instead, this article is intended to demonstrate damage to casting margins caused by microabrasion and to publicize the risks of casting damage to dentists and dental laboratory technicians.

Test Design

Polystyrene wafers (Brasseler USA, Savannah, GA), with a width of 24.5 mm, a length of 21 mm, and a thickness of 1.0 mm, were milled on one side, creating an 18° bevel of approximately 3 mm in length using a rotary lapping machine (Leco VP 160, Leco Corporation, St. Joseph, MI) and 600-grit sandpaper. The bevel terminated in a sharp edge, simulating a dental casting margin (Fig 1). The patterns were then invested (PowerCast, Whip Mix Corporation, Louisville, KY) and cast in

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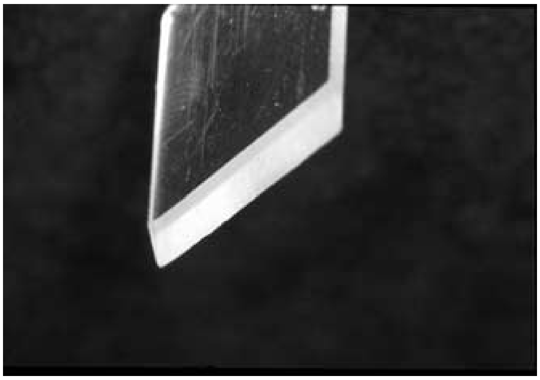

Figure 1. A plastic specimen is shown in an oblique view. Notice the beveled test site, simulating a dental casting margin.

one of five dental casting alloys (Table 1) following manufacturer's instructions.

After casting, the alloy specimens were grossly divested using blunt mechanical forces and rotary instruments. Care was taken not to damage the beveled test areas. Residual investment was removed with a hydrofluoric acid solution (Stripit, Keystone Industries, Cherry Hill, NJ) (Fig 2).

Using a surgical blade, reference lines were scribed within 1 mm of the beveled edge on the non-exposure side of each specimen. The lines allowed for pre- and post-test measurement of the specimens. The difference between pre- and post-test measurement represents the vertical height change in the specimen following exposure to the test conditions. All specimens were measured by one investigator using a measuring microscope (Olympus SZH 10, Olympus America Inc., Melville, NY) at 60× magnification and computer-supported, measurement software (Image-Pro Plus, v. 3.0.01.00, Media Cybernetics L.P., Silver Spring, MD). Though the software reported measurement variances of 1 μm, all results were reported to the nearest 10 μm, ensuring measurement reliability.

Following pre-test measurement, specimens were positioned in a holding device within the microabrasion unit (Micro/Blaster, Comco Inc., Burbank, CA). The holding device included a ball-and-socket joint that allowed for proper positioning of the specimen. The microabrasion handpiece was mounted onto a paralleling bracket attached to a dental surveyor, allowing control of the distance between the specimen and the handpiece.

In Test 1, specimens were positioned perpendicular to, and 15 mm from, the nozzle of the microabrasion handpiece (Fig 3A). In Test 2, specimens were positioned parallel to, and 15 mm from, the nozzle of the microabrasion handpiece (Fig 3B). The middle of the nozzle was aimed at the edge of the specimen in each test. Using 2 bar of pressure, specimens were exposed to a stream of 50 μm aluminum oxide particles (KerrLab, Orange, CA) for 10 seconds. Post-test measurements were then made. Each alloy was tested five times. A pre- and post-test specimen from Test 1 is shown in Figure 4. The results of Tests 1 and 2 are shown in Tables 2 and 3.

In light of significant specimen changes experienced while conducting Tests 1 and 2, two corollary tests were also performed. Tests 3 and 4 were designed similar to Tests 1 and 2 except for the substitution of 100 μm glass beads (KerrLab) for the 50 μm aluminum oxide particles. The alloys used in Tests 3 and 4 were Firmilay and Legacy (Table 1). A representative pre- and post-test specimen is shown in Figure 5. Tests 3 and 4 were accomplished to compare microabrasion outcomes of smaller, irregular aluminum oxide particles with that of larger, more uniform glass beads. The results of Tests 3 and 4 are shown in Tables 4 and 5.

Damage Encountered

The average differences between pre- and post-test measurements for Test 1 specimens are reported in Table 2. Differences for Test 2 are reported in Table 3. All specimens exposed to vertical or horizontal streams of aluminum oxide

Table 1. Dental Alloys (Reported as Weight %; VHN = Vickers Hardness Number)

1. Diamond (195 VHN)	88.4 Au, 9.58 Pt, 1.0 Mn, 0.6 Zn, 0.3 In, 0.12 Ir
2. Firmilay (220 VHN)	74.5 Au, 11 Ag, 10.495 Cu, 3.5 Pd, 0.5 Zn, 0.005 Ir
3. Genesis II (350 VHN)	53 Co, 27 Cr, 10 W, 3 Ga, 1.0 Ru, 1.0 Cu, 1.0 Ta, 1.0 Nb, 0.5 Fe, 0.5 Si
4. Legacy (285 VHN)	85.2 Pd, 10 Ga, 2 Au, 1.1 In, 0.9 Ag, 0.8 Ru
5. Olympia (255 VHN)	51.5 Au, 38.4 Pd, 8.5 In, 1.5 Ga, 0.1 Ru

All alloys manufactured by Jelenko Dental Health Products, Armonk, NY.

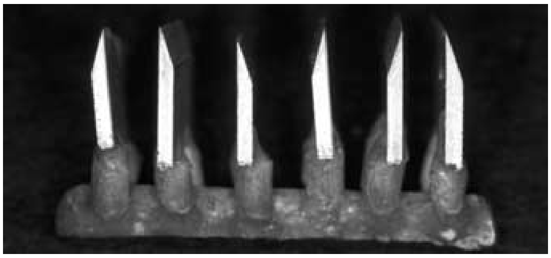

Figure 2. Test specimens are shown in a lateral view following casting and chemical divestment.

particles were damaged. The minimum amount of alloy loss for any metal type was a mean of 30 μm for the Genesis II samples as experienced in Test 2. Genesis II is a cobalt-chromium alloy that, due to its hardness, would be expected to better resist microabrasion degradation. The Test 1 Firmilay specimens recorded the greatest change of any alloy tested, with an average change of more than 0.2 mm in the vertical height of specimens.

The average differences between pre- and post-test measurements for Test 3 specimens are reported in Table 4. Differences for Test 4 are reported in Table 5. All specimens exposed to vertical or horizontal streams of glass beads were damaged.

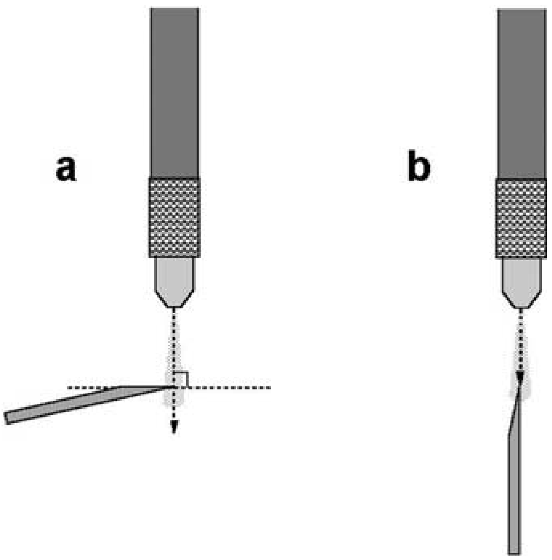

Figure 3. In Test 1, the microabrasion particle stream was directed perpendicular to the beveled surface of the specimen *(A)*. In Test 2, the particle stream was directed parallel to the specimen *(B)*.

Table 2. Test 1 Results (50 μm Aluminum Oxide, Perpendicular to the Specimen)

1. Diamond	100 μm (standard deviation = ±52 μm)
2. Firmilay	210 μm (±92 μm)
3. Genesis II	110 μm (±70 μm)
4. Legacy	50 μm (±30 μm)
5. Olympia	90 um (±46 μm)

Testing Relevance

Many practitioners are unaware of the potentially destructive power of microabrasion. To clearly demonstrate damage, laboratory-relevant testing conditions were used. Tests 1 and 3 represented the microabrasion exposure that casting margins might experience during cleaning and preparation for cementation, where the particle stream is directed perpendicular to the specimen's edge. Tests 2 and 4, with particles directed parallel to the specimen's edge, represented the probable exposure encountered during divestment procedures.

Test results varied in Tests 1 and 2. As an example, Genesis II was the least affected in Test 2, but recorded moderate damage in Test 1. Such variation could be explained by minor positional differences of the samples within the particle stream, variations in particle patterns within the particle stream, minor differences in the samples' edge thicknesses, alloy behavior depending on exposure direction, or a small sample size.

The selected alloys represent a variety of popular types. Pressure of 2 bar is a commonly used, low pressure setting on many microabraders. The 10-second exposure time and the 15-mm distance between the specimen and the abrader nozzle were established following observation of laboratory technicians who divested fixed partial dentures using microabrasion at the University of Texas Health Science Center at San Antonio. Those technicians divested fixed partial dentures

Table 3. Test 2 Results (50 μm Aluminum Oxide, Parallel to the Specimen)

1. Diamond	70 μm (standard deviation = ±80 μm)
2. Firmilay	140 μm (±81 μm)
3. Genesis II	30 μm (±40 μm)
4. Legacy	60 μm (±43 μm)
5. Olympia	80 um (±41 μm)

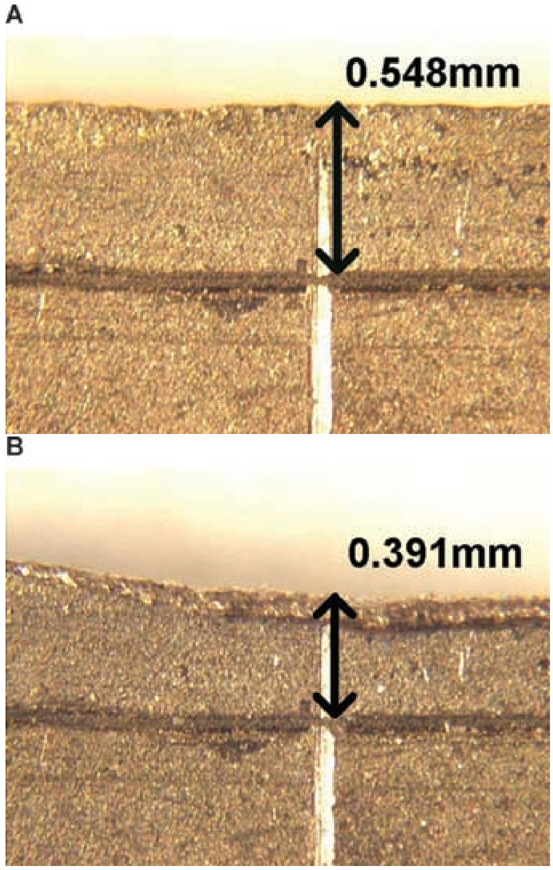

Figure 4. A specimen used in Test 1 is shown prior to testing *(A)* and after aluminum oxide microabrasion exposure *(B)*.

with an average of 1 minute and 37 seconds of microabrader use. With an appreciation for the frequency and duration of microabrader use during a variety of laboratory steps, 10 seconds of microabrasion contact appeared to be a reasonable test standard. Other investigators have speculated that castings cleaned in a dental laboratory via microabrasion may, in that procedure alone, experience a contact time greater than 5 seconds.[6]

Chemical divestment may damage dental casting alloys, especially non-precious ones. To ensure this potential damage was minimized, chemical divestment of the test specimens was performed

Table 4. Test 3 Results (100 μm Glass Beads, Perpendicular to the Specimen)

1. Firmilay	450 μm (standard deviation = $\pm$88 μm)
2. Legacy	240 μm ($\pm$39 μm)

Table 5. Test 4 Results (100 μm Glass Beads, Parallel to the Specimen)

1. Firmilay	400 μm (standard deviation = $\pm$29 μm)
2. Legacy	170 μm ($\pm$31μm)

for the shortest time possible while still attaining clean testing surfaces.

The damage experienced in this study should cause concern for technicians and dentists who routinely expose dental castings to microabrasion. Since 30 μm was the minimum mean specimen change following microabrasion, it appears that margins exposed to relatively low-pressure microabrasion are at risk for clinically significant damage. As more laboratory steps are supported by microabrader use, effects of microabrasion will be cumulative. Dental laboratory technicians and

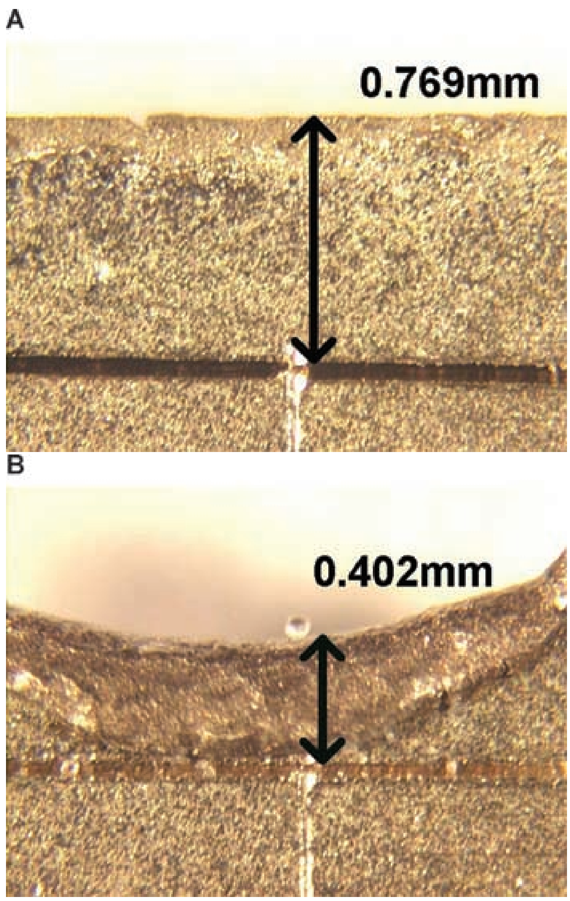

Figure 5. A specimen used in Test 4 is shown prior to testing *(A)* and after exposure to glass bead microabrasion *(B)*.

clinicians experiencing casting-fit discrepancies should assess the use of microabrasion during laboratory procedures. This is especially true since microabrasion has been shown to cause casting distortion (plastic deformation), affecting the quality of fit.[7,8]

As was presented by Peutzfeldt and Asmussen,[7] the increased mass of glass beads appears to increase the destructive potential of microabrasion. Substituting glass beads for aluminum oxide particles, therefore, may not be kinder to casting margins.

Clearly, all microabrasion does not cause damage of the magnitude reported in this study. Technique differences are one possible explanation, as well as the investigators' intent to directly target the margin, a practice minimized by the technician in the laboratory.

Conclusion

No statistical analysis of results was performed because this article was not focused on a comparison of alloy behavior. Instead, the alloy specimens were exposed to test conditions to assess damage risk. It is apparent from the results of this study that microabrasion can cause damage to casting margins. Appreciation of the damage potential is essential. Awareness of this risk, and the subsequent procedural changes in the dental laboratory, may reduce unnecessary damage to dental castings. Possible safeguards for microabrasion use include substituting techniques that require less microabrasion exposure, the selection of a particle with less mass, increased distance from the handpiece to the sample, and shorter exposure times.[7]

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