Short Communication

Effects of Simulated Clinical Grinding and Subsequent Heat Treatment on Microcrack Healing of a Lithium Disilicate Ceramic

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Grinding intaglio surfaces of ceramic restorations with diamond burs is a common procedure to improve fit. This study evaluated the effects of simulated diamond bur grinding and subsequent veneer firing and glazing on a lithium disilicate glass-ceramic. The results revealed a significant reduction in the roughness and strength of the material after diamond bur grinding, whereas the strength was restored through crack healing and formation of a glass layer after heat treatment. The finding indicates that grinding of lithium disilicate ceramics with diamond burs may introduce flaws and cracks, and therefore subsequent heat treatments, veneer firing, or glazing, are suggested. *Int J Prosthodont 2008;21:496–498.*

The structural reliability of veneered lithium disilicate restorations has been shown to be controlled primarily by that of the core ceramic.[1] However, there is concern that grinding during the fabrication of restorations might possibly weaken the strength of this core ceramic. Previous studies[2,3] performed grinding of lithium disilicate core ceramics with a series of silicon carbide papers mounted on a metallographic lapping machine and found no detrimental effects of grinding. It is obvious that dental ceramics treated with industrial grinding systems are not clinically applicable and might not necessarily represent the effect of grinding adjustments in the clinical situation.[4] However, there is no further information regarding the effects of clinical grinding procedures on lithium disilicate ceramic. As a consequence, information about veneering and glazing treatments on ground ceramics is lacking. The objectives of this study were to investigate the effects of simulated clinical grinding on the strength of lithium disilicate core ceramics and to verify the influence of subsequent veneer and glazing heat treatments on the ground core ceramics.

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Materials and Methods

Sixty disk specimens (14.7 mm in diameter × 1.3 mm in thickness) of Empress 2 core ceramic (shade 100, lot F19995, Ivoclar Vivadent) were fabricated according to the manufacturer's instructions and randomly divided into 6 groups (Table 1). To mimic clinical conditions, a 170-grit coarse diamond bur (2138L-037, Varenkor) was used for grinding. The specimens were secured in a special sample holder that allowed the long axis of the diamond bur to be set parallel to the test surface. The handpiece was moved back and forth 10 times along its horizontal plane while barely touching the specimen, and it was run at a medium speed (about 17,500 rpm) with a water coolant. The diamond bur was thoroughly cleaned between the grinding of each specimen; a new bur was used for each group of specimens.

Roughness Measurement

A profilometer (Surtronic 3+, Taylor Hobson) was used to determine the roughness of the specimens. Five readings were taken for each specimen, within the center area of each disk with a traveling distance of 4 mm, and the average values for roughness (Ra) were recorded.

Table 1 Specimen Preparation of the Various Groups

Group	Treatment
1 (C)	Control group (as pressed and divested)
2 (G)	Ground with a diamond bur
3 (GV)	Ground with a diamond bur, followed by simulated veneer firing
4 (V)	Simulated veneer firing
5 (VG)	Ground with a diamond bur after simulated veneer firing
6 (VGR)	Ground with a diamond bur after simulated veneer firing, followed by re-glazing

Table 2 Mean Values (SDs) for Roughness and Biaxial Flexural Strength*

Group	Ra (µm)	Flexural strength (MPa)
1 (C)	2.50 (0.42)[a]	283.2 (23.6)[a]
2 (G)	1.91 (0.26)[b]	233.7 (27.6)[b]
3 (GV)	1.89 (0.35)[b]	276.1 (28.2)[a]
4 (V)	2.47 (0.29)[a]	292.8 (32.5)[a]
5 (VG)	2.27 (0.30)[a,b]	231.8 (28.1)[b]
6 (VGR)	1.88 (0.24)[b]	281.9 (15.8)[a]

*Values in a column with the same superscript letter do not differ statistically significantly ($P > .05$).

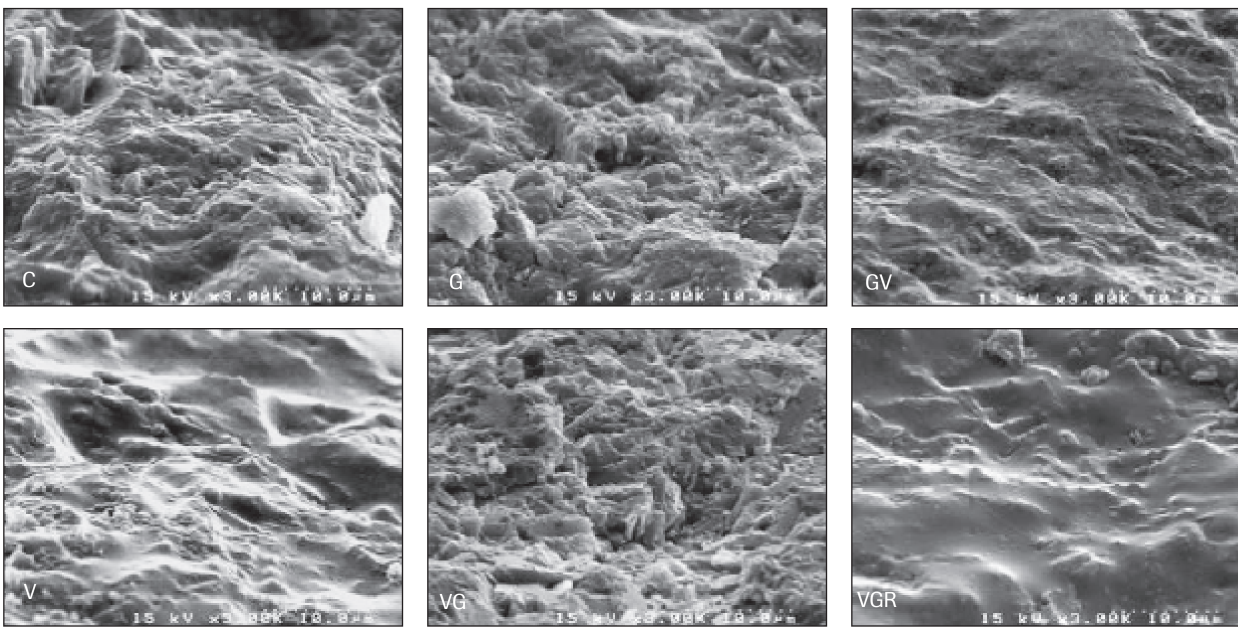


Fig 1 SEM micrographs (×3,000) of lithium disilicate core ceramics subjected to different surface treatments. C = control group (as pressed and delivered); G = ground with a diamond bur; GV = ground with a diamond bur, followed by simulated veneer firing; V = simulated veneer firing; VG = ground with a diamond bur after simulated veneer firing; VGR = ground with a diamond bur after simulated veneer firing, followed by re-glazing.

Microscopic Examination

Two specimens of each group were gold-coated using a sputter coater (E101, Hitachi), and the microscopic features of the treated surfaces were observed with a scanning electronic microscope (S-2700, Hitachi).

Biaxial Flexural Testing

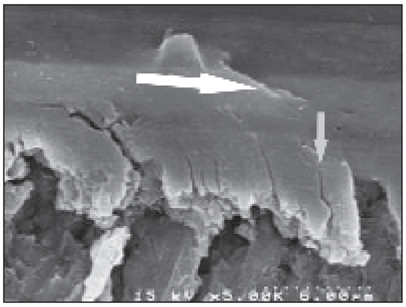
The remaining specimens were centered and supported by 3 steel spheres (3.12 mm in diameter) positioned 120 degrees apart on a circle (10 mm in diameter) with the treated surface in tension. The loaded surface of each specimen was covered with a thin plastic sheet (0.05 mm) to distribute the load evenly under a flat-ended loading cylinder (0.96 mm in diameter). The specimens were loaded at 0.5 mm/min until fracture, and the biaxial flexural strengths were derived.

Statistical Analysis

Data were analyzed with 1-way analyses of variance and the Tukey test for multiple comparisons ($\alpha = .05$).

Results

Grinding with a diamond bur significantly reduced the flexural strength of the as-pressed (C) and as-veneered (V) core ceramics, whereas subsequent veneering (GV) or glazing treatment (VGR) restored the strength of the ground core ceramics (Table 2). In addition to reducing the flexural strength of the ceramic, simulated clinical grinding with diamond burs also significantly decreased the surface roughness of the test ceramic, whereas subsequent heat treatment of GV and VGR specimens resulted in a new glass coating and relatively smooth surfaces (Fig 1). A typical ground surface



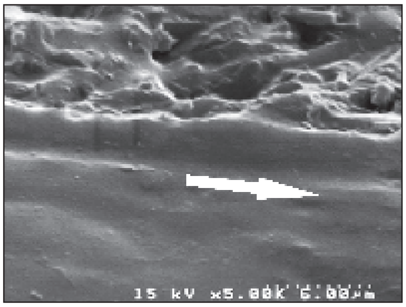


Fig 2a *(left)* Scanning electron micrograph (×5,000) showing the surface flaws on a ground specimen (from group GV). White arrow = direction of grinding; gray arrow = multiple microcracks propagating perpendicular to the grinding direction.

Fig 2b *(right)* Scanning electron micrograph showing that the cracks were filled with glass on an annealed specimen (from group GVR). White arrow = direction of grinding.

is shown in Fig 2a at higher magnification (×5,000). Two sets of flaws, one parallel and the other perpendicular to the grinding direction, revealed the surface damage caused by grinding. These flaws were resolved by the new glass coating that was created during the veneering or glazing heat treatment (Fig 2b).

Discussion

Internal grinding of core ceramics is a common means to obtain the best fit during coping try-in or final delivery of all-ceramic restorations. In this study, intaglio grinding of core ceramic with diamond burs was shown to induce detrimental microcracks and result in reductions in flexural strength and reliability. Furthermore, the cracks induced during the coping try-in stage were effectively healed by subsequent veneering procedures; those generated in the final delivery stage might require an additional glazing treatment to be repaired.

References

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Literature Abstract

Clinical and inflammatory effects of galvano-ceramic and metal-ceramic crowns on periodontal tissues

The purpose of this prospective, blinded, randomized clinical trial of a split-mouth desig, was to test the impact of metal ceramic (MC) and galvano-ceramic (GC) crowns on clinical and inflammatory responses on periodontal tissues. A framework of GC is created by a computer-controlled process of galvanization, which involves the deposition of gold ions onto a conductible surface under electrical current. The inclusion criteria included good oral and general health, indication to crown teeth of the same group on both sides of the mouth, vital teeth, and willingness to participate in the study. A total of 52 patients with 104 crowns were placed in this study. Prior to placement of crowns, the gingival index (GI), plaque index (PI), periodontal recession, and probing depths were taken at 6 sites by a blinded examiner. The gingival crevicular fluid was also tested for Ig G using the ELISA test and crevicular fluid flow rate (CFFR) was also recorded using a Periotron. The crowns were prepared with a 1 mm chamfer all around at the level of the gingiva (iso-gingivally) with an incisal reduction of 2 mm and cemented with zinc phosphate cement. These tests were repeated at baseline, 2 weeks, 6 months, and annually post-insertion of the crowns. The results showed that at the 12-month and 24-month follow-up, there was a statistically lower PI and GI for the GC crowns compared to the MC. PI, GI, CFFR, and Ig G were all statistically less at GC sites. In the evaluation of buccal and palatal sites at 12 months, PI and GI were statistically less at the oral sites for GC but higher for MC. At 24 months, PI, GI, CFFR, and Ig G were statistically less at oral sites for GC. This research suggests a stabilizing effect of GC on periodontal tissues but it cannot be concluded whether this is due to less plaque retention, lack of non-precious components leading to sensitivity, or better fitting accuracy.

Weishaupt P, Bernimoulin JP, Lange KP, Rothe S,Naumann M, Hägewald S *J Oral Rehabil* 2007;34;941-947. **References:**26 **Reprints:** Dr Peggy Weishaupt, Ludwig-Maximilians University, Goethestr. 70, 80336 Munich, Germany—*Seetoh YL, Singapore*