

RESEARCH AND EDUCATION

Wear resistance and abrasiveness of CAD-CAM monolithic materials



Francesco Saverio Ludovichetti, DDS,^a Flávia Zardo Trindade, DDS, MSc, PhD,^b Arie Werner, Ing,^c Cornelis Johannes Kleverlaan, PhD,^d and Renata Garcia Fonseca, DDS, MSc, PhD^e

An improvement in the esthetics of lithium disilicate and yttria-stabilized tetragonal zirconia ceramics has led to monolithic restorations, eliminating the problem of fracture and chipping of veneering porcelain.¹ In addition, the advent of computer-aided design and computer-aided manufacturing (CAD-CAM) technology has enabled restorations to be provided in a single session.² More recently, other esthetic CAD-CAM monolithic materials with similar indications as lithium disilicate and yttria-stabilized tetragonal zirconia ceramic have been introduced. These include zirconia-reinforced lithium silicate ceramic, polymer-infiltrated ceramic, and nanofilled composite resin.

In the absence of veneering porcelain, these materials are in contact with the antagonist, which can be a natural tooth or

ABSTRACT

Statement of problem. Computer-aided design and computer-aided manufacturing (CAD-CAM) restorations are in contact with the antagonist tooth, either a natural tooth or a restoration. Therefore, clinicians should be aware of the wear resistance of CAD-CAM materials and the wear behavior of the antagonist.

Purpose. The purpose of this in vitro study was to evaluate the wear resistance and abrasiveness of CAD-CAM materials.

Material and methods. In a 2-body wear test, the materials IPS e.max CAD (Ivoclar Vivadent AG), Vita Suprinity (Vita Zahnfabrik), Lava Ultimate (3M ESPE), Vita Enamic (Vita Zahnfabrik), and Lava Plus (3M ESPE) acted as abraders and, together with bovine enamel, also as antagonists. Each antagonist wheel ran against each abraded wheel for 200 000 cycles, with a spring force of 15 N, and at a rotational speed of 1 Hz in distilled water. The wear rate was determined with a surface profilometer. The surfaces were observed with scanning electron microscopy, and their hardness, coefficient of friction, and roughness were evaluated.

Results. Lava Plus and IPS e.max CAD exhibited the highest potential for wear of Lava Ultimate. These 2 materials, together with Vita Suprinity, provided the highest wear of enamel and Vita Enamic. Vita Suprinity and IPS e.max CAD had higher wear than Lava Plus, and the inverse was also true. Vita Enamic and Lava Ultimate were among the materials that caused the lowest wear of enamel and all other evaluated materials. Scanning electron microscopy images revealed that except for Lava Ultimate, all other materials damaged enamel, in which Vita Suprinity and IPS e.max CAD were more aggressive when sliding against the materials. Lava Plus had the greatest hardness, followed by Vita Suprinity and IPS e.max CAD, Vita Enamic, and then Lava Ultimate. The coefficient of friction varied from 0.42 to 0.53. The Vita Enamic and Lava Ultimate showed the highest surface roughness.

Conclusions. The nanofilled composite resin and polymer-infiltrated ceramic were more antagonist-friendly (whether enamel or CAD-CAM material) than glass-ceramics and zirconia. Care should be taken when selecting the material that will contact mainly with glass-ceramics. Hardness should also be considered when selecting a material. (J Prosthet Dent 2018;120:318.e1-e8)

Funding: This work was supported by the São Paulo Research Foundation (FAPESP) (grant: 2014/15637-7).

^aPostgraduate student, Department of Dental Materials and Prosthodontics, School of Dentistry, São Paulo State University (UNESP), Araraquara, Brazil.

^bPostdoctoral student, Department of Dental Materials and Prosthodontics, School of Dentistry, São Paulo State University (UNESP), Araraquara, Brazil.

^cEngineer, Department of Dental Materials Science, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam; and Vrije University Amsterdam, Amsterdam, The Netherlands.

^dProfessor, Department of Dental Materials Science, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam; and Vrije University Amsterdam, Amsterdam, The Netherlands.

^eAssociate Professor, Department of Dental Materials and Prosthodontics, School of Dentistry, São Paulo State University (UNESP), Araraquara, Brazil.

Clinical Implications

Nanofilled composite resin and polymer-infiltrated ceramics are antagonist-friendly materials, whereas glass-ceramics promote high wear rates on the antagonist enamel and materials. Hardness should be considered when selecting CAD-CAM monolithic materials. The roughness and coefficient of friction of some materials may change during the wear process.

a restoration. Therefore, the wear resistance and abrasiveness of these materials is important. The wear properties of zirconia,³⁻⁸ lithium disilicate,^{3,4,6,9,10,11} zirconia-reinforced lithium silicate,¹⁰ polymer-infiltrated ceramic, and nanofilled composite resin^{6,10,12} when opposed to enamel have been reported. However, the multifactorial nature of wear^{6,13,14} makes it important to understand the wear potential of the materials based on the composition and microstructural aspects¹⁵⁻¹⁷ that will determine their properties.¹⁸⁻²⁴ The role that the roughness,^{6-9,25} coefficient of friction,^{4,14} elastic modulus,¹⁰ and hardness^{6,14,15} play in determining wear potential has been investigated.

However, these studies used enamel as an antagonist,^{4,5,7-13,15,26} and studies exploring the different possibilities of combinations among these materials are lacking. Therefore, the purpose of the present study was to evaluate the wear provided by 5 CAD-CAM monolithic materials on bovine enamel and on each other. To better understand the material behavior, the surface roughness, hardness, and coefficient of friction of the materials were also investigated. The null hypothesis was that no difference would be found among the materials regarding their potential to wear the enamel or each other.

MATERIAL AND METHODS

The materials used in the present study and their composition are listed in [Table 1](#). Disk-shaped specimens were prepared from each material. The CAD-CAM blocks were shaped into cylinders by using a mechanical turner, cut into disks using a precision saw (IsoMet 1000; Buehler), and then polished with silicon carbide abrasive papers (400-, 600-, 1200-grit papers; 3M) in a polisher (Metaserv 2000; Buehler) under water irrigation. Vita Suprinity (Vita Zahnfabrik) and IPS e.max CAD (Ivoclar Vivadent AG) disks were crystallized (Programat P310; Ivoclar Vivadent AG). Lava Plus (3M ESPE) disks were cut 20% thicker and then sintered (inFire HTC speed; Dentsply Sirona). Crystallization and sintering were performed by following the manufacturers' recommendations.

For the microhardness test ($n=5$), 5 indentations were made in each specimen using a Vickers diamond indenter under 20-N load and a 20-second dwell time. Hardness values (GPa) were calculated according to the equation $H=P/2d^2$, where P is the load in newtons and d is the average of the diagonal values.

The coefficient of friction ($n=5$) was measured using a ball-on-flat tribometer (UMT-2; CETR Corp) according to ASTM G133-05 Standard.²⁷ Each specimen was secured on a holder, and a load of 5 N was applied with a 2-mm-diameter stainless steel sphere. A tangential, cyclic 9.7-mm back and forward motion was applied to the specimen at 5 Hz for 600 seconds without irrigation. A new stainless steel ball was used for each specimen. Testing was conducted at room temperature and humidity.

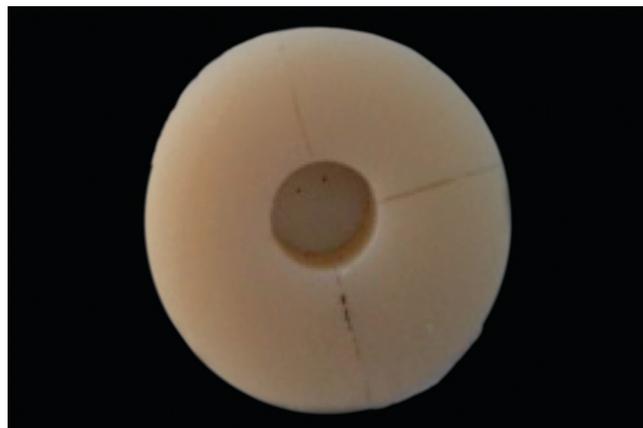
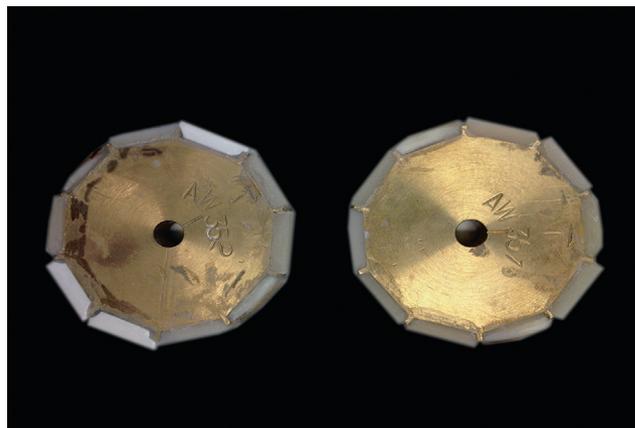
Surface roughness (μm) ($n=8$) was analyzed using a confocal microscope (LEXT OLS4100; Olympus). Three equidistant parallel measurements were made on each specimen. The average reading was designated as the R_q (root mean square roughness) value of each specimen. A single calibrated operator (F.S.L.) recorded all measurements.

The 2-body wear test was performed using the Academic Centre for Dentistry Amsterdam (ACTA) wear machine profiles.^{28,29} One wheel (of 21-mm diameter and 7.5-mm width) containing a 2-mm inner hole (abrader wheel) from each material was prepared ([Fig. 1](#)). After gluing 4 CAD-CAM blocks of each material together, a round diamond tip with an inner diameter of 21 mm was mounted on a table drill and used to obtain the abrader wheels under constant water irrigation. An inner hole of 2 mm was obtained following the same procedure. The round tip used for the Lava Plus had an inner diameter of 26 mm to compensate for zirconia shrinkage. Then, the IPS e.max CAD and Vita Suprinity were crystallized, and the Lava Plus was sintered. Each wheel was then mounted on the ACTA wear machine and polished against sequential abrasive wheels to obtain an even and curved cylindrical outer surface shape. A final polish of the outer surfaces was given using P1000 silicon carbide abrasive paper mounted on a wheel. Two antagonist metal wheels (of 48-mm diameter and 10-mm thickness) with 10 rectangular compartments (of 14-mm length, 10-mm width, and a maximum of 3-mm thickness) were used. Rectangular specimens (3 from each material, 4 from bovine enamel, and 1 from Z250 composite resin) were bonded using Panavia F2.0 (Kuraray Dental) to the antagonist wheel compartments of the ACTA wear machine ([Fig. 2](#)). Each specimen wheel was polished following the same protocol used for the abrader wheel. Finally, each abrader wheel rotated against each antagonist wheel.

Each antagonist wheel ran for 200 000 cycles with a spring force of 15 N at a rotational speed of 1 Hz in distilled water at room temperature. Then, 10 tracings were made

Table 1. Materials used in study

Material	Classification	Composition	Manufacturer
Lava Ultimate	Resin nanoceramic	80% nanoceramic and 20% resin matrix	3M ESPE
Vita Enamic	Polymer-infiltrated ceramic network	86% feldspathic ceramic and 14% polymer	Vita Zahnfabrik
Vita Suprinity	Zirconia-reinforced lithium silicate ceramic	Lithium silicate with ~ 10% ZrO ₂	Vita Zahnfabrik
IPS e.max CAD	Lithium disilicate ceramic	57%-80% SiO ₂ , 11%-19% Li ₂ O, 0%-13% K ₂ O, 0%-11% P ₂ O ₅ , 0%-8% ZrO ₂ , 0%-8% ZnO, 0%-5% Al ₂ O ₃ , 0%-5% MgO	Ivoclar Vivadent AG
Lava Plus	Tetragonal polycrystalline zirconia partially stabilized with 3mol-% yttria	99% ZrO ₂	3M ESPE

**Figure 1.** Abrader wheel from Vita Enamic before polishing.**Figure 2.** Antagonist wheels before polishing.

at fixed positions on the worn surface of the specimens using a surface profilometer (PRK profilometer no. 20702; Perthen GmbH) to determine the loss of material in μm . The average wear rate was calculated from these profiles.^{28,29} The worn surfaces were observed by scanning electron microscopy at $\times 100$, $\times 500$, $\times 1000$, $\times 2000$, $\times 5000$, and $\times 10\,000$ (LS15; Zeiss). Scanning electron microscopy (SEM) specimens were made indirectly from epoxy resin (Araldite; Ciba-Geigy) poured into a polyvinyl siloxane impression and gold sputtered for electron conductivity.

The hardness and roughness data were square root transformed before the statistical analysis. Because the assumptions of the analysis of variance were satisfied (Shapiro-Wilk and Levene tests, $P > .05$), the hardness, coefficient of friction, and roughness data were submitted to 1-way ANOVA test, followed by the Tukey post hoc test ($\alpha = .05$) to determine significant differences among the materials. The wear data were analyzed by 2-way ANOVA (abrader and antagonist), followed by the Tukey post hoc test. A statistical analysis was performed using a statistical software program (IBM SPSS Statistics v22.0; IBM Corp).

RESULTS

Table 2 shows the Vickers hardness mean values, standard deviations, and the statistical results ($F = 1898.12$;

$P < .001$). The hardness result was Lava Plus > (Vita Suprinity = PS e.max CAD) > Vita Enamic (Vita Zahnfabrik) > Lava Ultimate (3M ESPE). Table 3 presents the coefficient of friction mean values, standard deviations, and statistical results ($F = 6.126$; $P < .01$). Lava Ultimate exhibited a higher coefficient of friction than IPS e.max CAD and Lava Plus. Roughness mean values (R_q), standard deviations, and statistical results ($F = 167.88$; $P < .001$) are shown in Table 4. Vita Enamic and Lava Ultimate showed the highest roughness values, whereas the IPS e.max CAD and Vita Suprinity exhibited the lowest mean value. The 2-way ANOVA indicated that the abrader ($F = 31.37$; $P < .001$) and antagonist ($F = 114.66$; $P < .001$) factors and their interaction ($F = 29.62$; $P < .001$) were significant. Table 5 presents the antagonist wear provided by the abrader materials. The IPS e.max CAD, Lava Plus, and Vita Suprinity materials provided higher wear of enamel than the Lava Ultimate and Vita Enamic. Lava Plus and the IPS e.max CAD showed significantly higher potential to wear than the Lava Ultimate. The wear of the Vita Enamic against different materials exhibited the same behavior as the enamel. Vita Suprinity and IPS e.max CAD exhibited the highest wear against the Lava Plus and the lowest against Vita Enamic and Lava Ultimate. IPS e.max CAD and Vita Suprinity exhibited the highest potential to wear against the Lava Plus.

Table 2. Mean Vickers hardness (VH), \pm SD, and statistical results

Material	Mean	Statistical Results
Lava Ultimate	96 \pm 6	A
Vita Enamic	200 \pm 5	B
Vita Suprinity	632 \pm 17	C
IPS e.max CAD	617 \pm 44	C
Lava Plus	1343 \pm 47	D

SD, standard deviation. Different uppercase letters indicate significant differences ($P < .05$).

The SEM images of the enamel surface worn by the materials (Fig. 3) revealed deep parallel grooves with broken fragments of Vita Suprinity (Fig. 3C) and a deeply pitted surface when sliding against the IPS e.max CAD (Fig. 3B). Sliding grooves were created by the Lava Plus (Fig. 3E). Slight cracks were caused by Vita Enamic (Fig. 3D), whereas an essentially smooth surface was detected when the enamel was rubbed against the Lava Ultimate (Fig. 3A). SEM images of the surface of the materials against themselves are presented in Figure 4. Lava Ultimate did not modify the surface of the materials, but some of its fragments can be seen on the surface of the Vita Suprinity (Fig. 4A) and IPS e.max CAD (Fig. 4B). Vita Enamic created superficial grooves on the Lava Ultimate (Fig. 4C). Vita Suprinity produced some pits on the Lava Ultimate (Fig. 4D) and Vita Enamic (Fig. 4E), whereas the surfaces of the other materials were flat with some fragments of Vita Suprinity on the IPS e.max CAD (Fig. 4F). Pits created by the IPS e.max CAD can be found on the Vita Enamic (Fig. 4G) and Vita Suprinity (Fig. 4H), whereas smooth flat surfaces were observed for the IPS e.max CAD itself and the Lava Plus. Finally, flat surfaces of Lava Ultimate, Vita Enamic, and Vita Suprinity were created when sliding against the Lava Plus. Some SEM images were lost because of technical problems, and therefore, some of them were repeated at a different magnification.

DISCUSSION

In the present study, the 2-body wear produced by CAD-CAM monolithic materials on bovine enamel and on themselves^{28,29} was evaluated. The null hypothesis that no difference would be found among the materials regarding their potential to wear the enamel and themselves was rejected. The enamel wear provided by all the tested materials after simulation of 200 000 cycles was lower than the clinical 2- and 3-body wear determined in vivo by Lambrechts et al²⁶ after 1 year. Nevertheless, ranking the restorative materials based on their potential to wear enamel is important, especially in patients with high occlusal force and/or bruxism.

In general, Lava Plus and IPS e.max CAD wore the antagonists more than Vita Enamic and Lava Ultimate did, and no significant difference was found in wear potential, either between IPS e.max CAD and Suprinity

Table 3. Mean coefficient of friction, \pm SD, and statistical results

Material	Mean	Statistical Results
Lava Ultimate	0.53 \pm 0.05	A
Vita Enamic	0.50 \pm 0.04	ABC
Vita Suprinity	0.51 \pm 0.05	AB
IPS e.max CAD	0.45 \pm 0.04	BC
Lava Plus	0.42 \pm 0.02	C

SD, standard deviation. Different uppercase letters indicate significant differences ($P < .05$).

Table 4. Mean roughness (Rq) (μ m) of polished surfaces, \pm SD, and statistical results

Material	Mean	Statistical Results
Lava Ultimate	0.37 \pm 0.09	A
Vita Enamic	0.40 \pm 0.06	A
Vita Suprinity	0.05 \pm 0.01	C
IPS e.max CAD	0.05 \pm 0.01	C
Lava Plus	0.29 \pm 0.04	B

SD, standard deviation. Different uppercase letters indicate significant differences ($P < .05$).

(except for Lava Ultimate antagonist) or between Vita Enamic and Lava Ultimate. Other studies also reported that the IPS e.max CAD showed significantly higher enamel wear than the Vita Enamic¹⁰ and Lava Ultimate.^{6,10} In these studies, as in the present, the IPS e.max CAD showed significantly higher hardness than the Vita Enamic and Lava Ultimate. In addition to the IPS e.max CAD, Lava Plus also exhibited significantly higher hardness than Vita Enamic and Lava Ultimate. Differently from other studies¹⁴⁻¹⁶ that did not find a strong relationship between hardness and wear potential, Mormann et al⁶ reported that the lower the hardness, the lower the enamel wear, which is in accordance with the present study. We also observed that the lower the hardness, the lower the antagonist materials' wear. Considering the hardness of the enamel reported by Chun et al¹⁸ (274.8 VH) and that found in the present study for the Lava Ultimate, Vita Enamic, IPS e.max CAD, Vita Suprinity, and Lava Plus, we observed that the materials with higher hardness than that of enamel presented higher enamel wear than those with lower hardness. In contrast with our result for the Lava Plus, Mormann et al⁶ found that the inCoris (Dentsply Sirona), despite its high hardness value, provided the lowest enamel wear rate among the evaluated materials. Possibly, this is related to differences in grain size, composition, or manufacturing process. According to Seghi et al,¹⁵ an understanding of the materials' microstructure might be useful in predicting their wear potential.

Besides hardness, other properties may be useful in determining the wear potential of the materials. Wang et al⁴ reported that when the mismatch of the elastic modulus and the strength between the enamel and

Table 5. Mean antagonist wear (μm), $\pm\text{SD}$, and statistical results

Abrader	Antagonist					
	Enamel	Lava Ultimate	Vita Enamic	Vita Suprinity	IPS e.max CAD	Lava Plus
Lava Ultimate	1.8 \pm 1.0 Ba	1.2 \pm 1.1 Bab	0.2 \pm 1.0 Bbc	0.7 \pm 0.4 Cab	-0.1 \pm 0.5 Cc	-0.2 \pm 0.3 Bc
Vita Enamic	0.9 \pm 1.9 Bab	2.2 \pm 2.4 Ba	0.5 \pm 0.6 Bab	0.6 \pm 1.2 Cab	0.5 \pm 1.4 Cab	-0.1 \pm 0.5 Bb
Vita Suprinity	3.8 \pm 4.0 Aa	1.8 \pm 1.6 Ba	4.3 \pm 5.3 Aa	2.4 \pm 3.3 Ba	2.9 \pm 3.5 Ba	0.1 \pm 0.6 ABa
IPS e.max CAD	6.0 \pm 7.3 Aa	4.0 \pm 2.6 Aa	4.0 \pm 4.6 Aa	3.2 \pm 3.9 Ba	2.3 \pm 2.8 Ba	0.4 \pm 0.6 Aa
Lava Plus	5.4 \pm 1.9 Ac	4.2 \pm 2.6 Ac	6.5 \pm 3.4 Abc	14.5 \pm 5.5 Aa	13.8 \pm 5.6 Aab	0.0 \pm 0.3 Bd

SD, standard deviation. Different uppercase letters indicate significant differences in columns ($P < .05$). Different lowercase letters indicate significant differences in rows ($P < .05$).

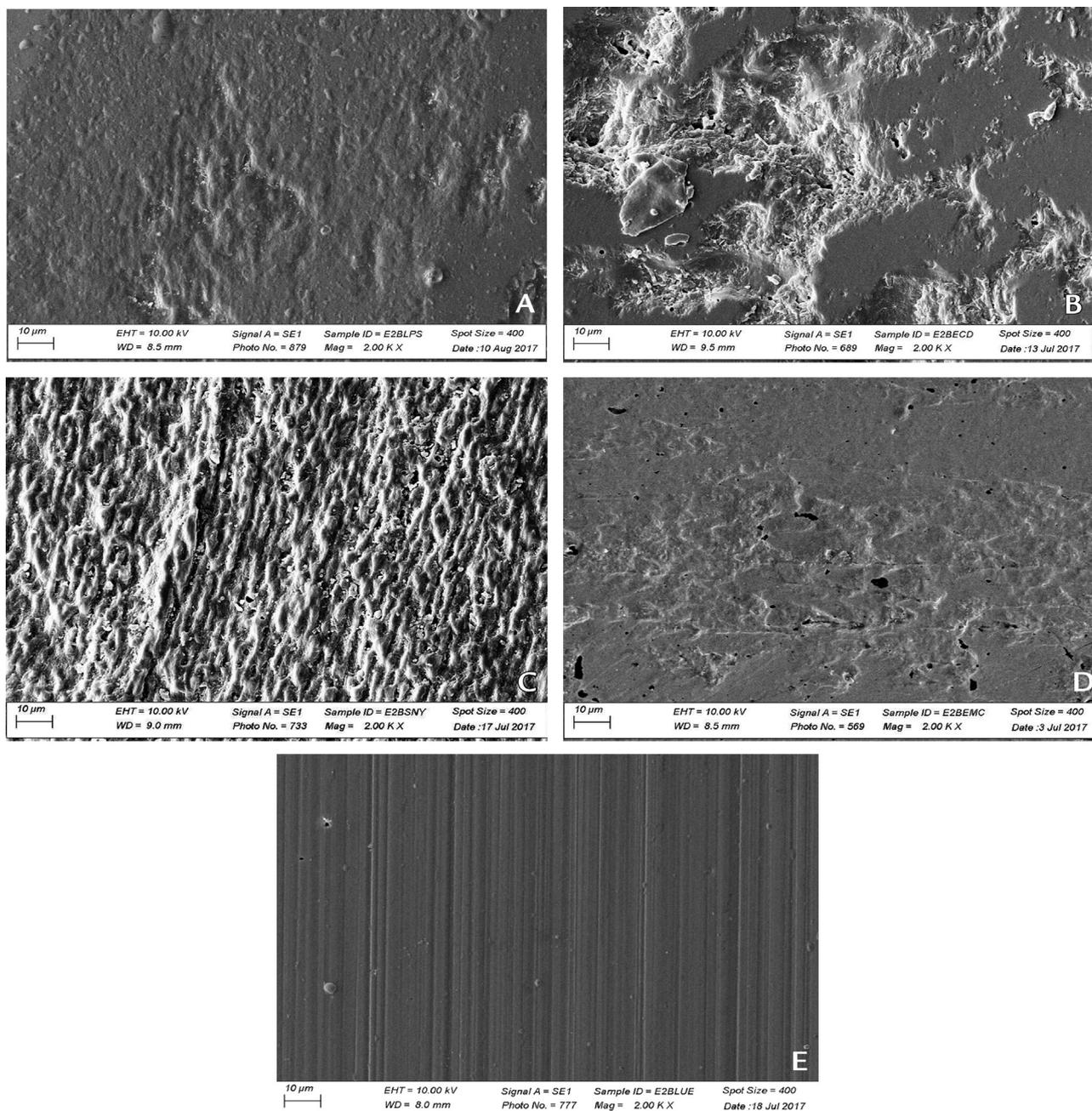


Figure 3. Scanning electron microscope images (original magnification $\times 2000$) of enamel surfaces. A, Against Lava Ultimate. B, Against Vita Enamic. C, Against Vita Suprinity. D, Against IPS e.max CAD. E, Against Lava Plus.

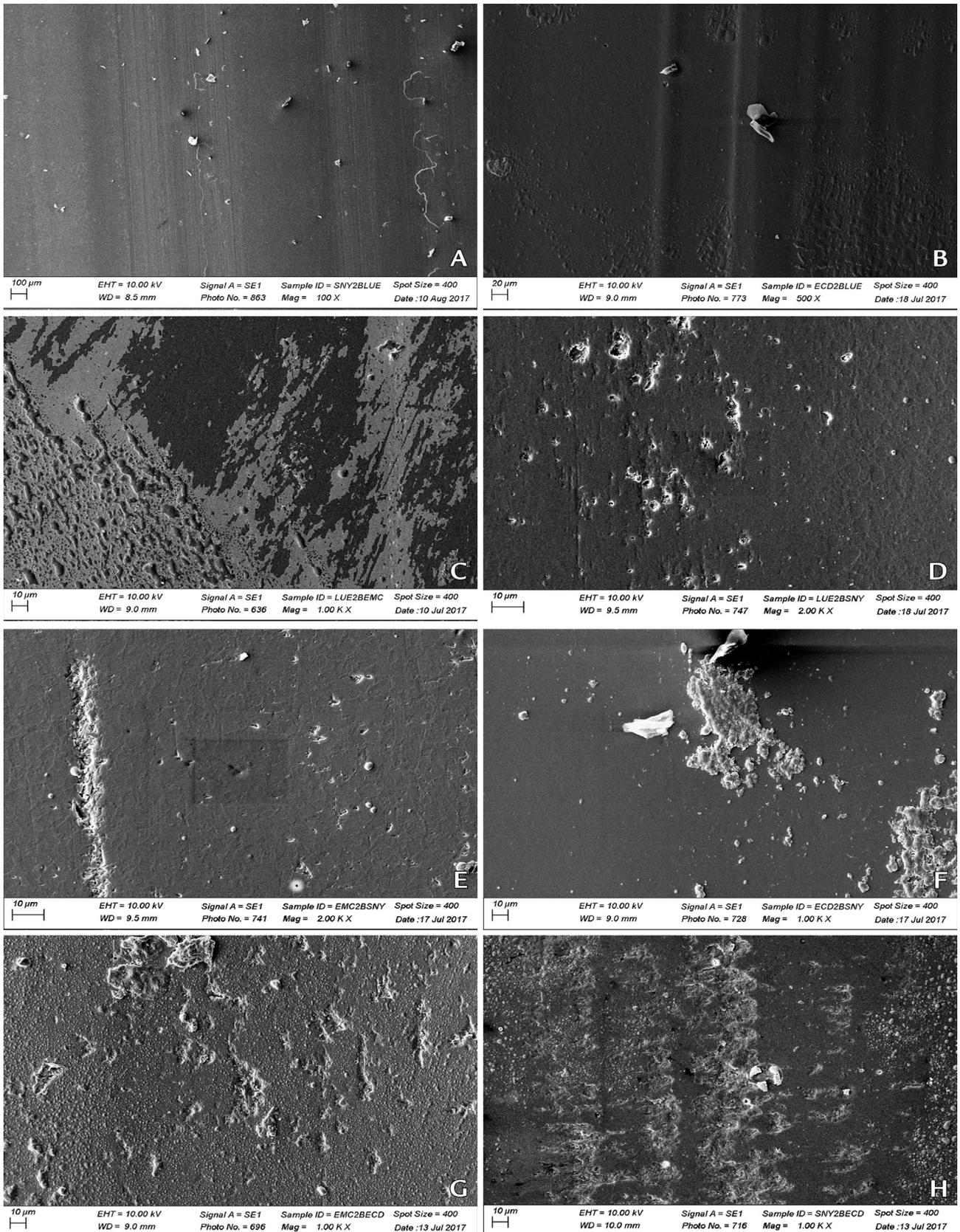


Figure 4. Scanning electron microscope images. A, Vita Suprinity surface against Lava Ultimate (original magnification $\times 100$). B, IPS e.max CAD surface against Lava Ultimate (original magnification $\times 500$). C, Lava Ultimate surface against Vita Enamic (original magnification $\times 1000$). D, Lava Ultimate surface against Vita Suprinity (original magnification $\times 2000$). E, Vita Enamic against Vita Suprinity (original magnification $\times 2000$). F, IPS e.max CAD against Vita Suprinity (original magnification $\times 2000$). G, Vita Enamic against IPS e.max CAD (original magnification $\times 1000$). H, Vita Suprinity against IPS e.max CAD (original magnification $\times 1000$).

restorative materials are large, the enamel suffers high stress concentration and, consequently, stress abrasion. They stated⁴ that the high strength and toughness of zirconia enabled it to resist surface damage under stress, keeping its fineness and coefficient of friction unchanged over time. In contrast, enamel suffers fatigue wear with microcrack formation and propagation in the subsurface.^{4,5} Therefore, high hardness combined with high flexural strength (1200 MPa) and elastic modulus (210 GPa) may explain the considerable wear potential of the Lava Plus. In addition, as the specimens were exposed to water during the entire experiment, the low temperature degradation of zirconia with an increase in surface roughness¹⁹⁻²¹ might have contributed to the high abrasion of the antagonists. In contrast, the elastic modulus of the IPS e.max CAD (67.2 GPa¹⁰ and 95 GPa according to the manufacturer) was similar to that of enamel (60 to 100 GPa²²).

Despite the differences in the composition and microstructure¹⁷ of the lithium disilicate (IPS e.max CAD) and the zirconia-reinforced lithium silicate (Vita Suprinity) materials, they were not statistically different concerning the properties evaluated. In addition, Belli et al¹⁷ reported that the Young modulus of these materials was similar. These similar properties explain the similarity in wear behavior found for IPS e.max CAD and Vita Suprinity.

Vita Enamic and Lava Ultimate showed the 2 lowest hardness values among all materials, whereas in the study by Mormann et al,⁶ the hardness of the Vita Enamic was not significantly higher than that of the Lava Ultimate. In addition, the elastic modulus of 21.5 GPa and 16.0 GPa found for the Vita Enamic and Lava Ultimate, respectively,¹⁰ is close to that of human dentin (20 GPa)²³ as has been reported by Awada and Nathanson.²⁴ The low stiffness and hardness explain the lower potential of the Vita Enamic and Lava Ultimate to wear enamel and other materials. Lawson et al¹⁰ observed that IPS e.max CAD and the zirconia-reinforced lithium silicate material, Celtra Duo, with a similar microstructure to that of Vita Suprinity,¹⁷ were generally stronger, stiffer, and harder than Vita Enamic and Lava Ultimate. The similarity in wear potential observed in the present study was also reported by Mormann et al⁶ stating that the hybrid ceramic behaved similarly to composite resins concerning enamel wear.

A relationship was not found between roughness, coefficient of friction, and wear behavior. Lava Plus and IPS e.max CAD exhibited significantly higher wear potential but lower roughness than Vita Enamic and Lava Ultimate and a lower coefficient of friction than the Lava Ultimate. Mormann et al⁶ reported that the IPS e.max CAD showed the lowest roughness value among all the evaluated materials (including Lava Ultimate, Vita Enamic, and inCoris) and significantly higher wear potential than the Lava Ultimate and inCoris. In contrast

with some authors^{7,25} who concluded that surface roughness influences and may predict enamel wear, the lack of a relationship found in the present study between surface roughness and wear potential is consistent with other studies.^{8,9} During cyclic sliding, some materials may undergo changes in surface topography, which might modify their abrasiveness.^{13,15} IPS e.max CAD contains approximately 70% lithium disilicate crystals in a glassy matrix. Wang et al⁴ reported that during wear against enamel, the lower strength and softer glass matrix of the lithium disilicate glass-ceramic wears more easily than the stronger and harder crystals, increasing the surface roughness and the coefficient of friction of the material. In addition, Culhaoglu and Park¹¹ assumed that after the lithium disilicate loses the glaze, an increased rate of particle fracture occurs. The presence of material debris between the rubbing surfaces might increase the friction and accordingly the wear rate, both from the glass-ceramic and enamel. These facts, along with the high hardness, explain the high enamel and antagonist material wear associated with IPS e.max CAD. The SEM images reported by Wang et al⁴ of the worn enamel surface against lithium disilicate reveal an abrasive wear, with rough furrows with enamel granules chipped off, extruded lithium disilicate crystalline grains and fragments. Therefore, some materials may have their surface roughness and coefficient of friction changed during the wear process, explaining the poor relationship between these 2 properties and the wear potential. Metzler et al¹³ evaluating the wear of enamel provided by feldspathic porcelains commented that the surface of the material is important in the beginning, but after the surface has been changed, the nature of the material determines the wear rates.

The SEM images of the enamel surface worn by the Vita Suprinity and IPS e.max CAD indicate an abrasive wear mechanism, as observed by some authors for IPS e.max CAD.^{4,10,11} The sliding grooves created by the Lava Plus differ slightly from the observations of the study by Stawarczyk et al⁵ in which cracks were observed on the enamel surface worn by polished monolithic zirconia. The Vita Enamic produced small cracks and Lava Ultimate an essentially smooth surface, which is in agreement with the images reported by Mormann et al.⁶ The SEM images of the materials show that the Lava Ultimate and Lava Plus did not damage the surface of the materials, despite the high wear rate produced by this last material. In contrast, the Vita Suprinity and IPS e.max CAD caused more damage to the materials. Some pits were observed on the surface of the Lava Ultimate and Vita Enamic when against Vita Suprinity. Pits were also present on the surface of the Vita Enamic and Vita Suprinity as a result of the sliding against the IPS e.max CAD with supposed fragments of Vita Suprinity on the surface of this last material, suggesting an abrasive wear mechanism.

A limitation of this study was that the enamel was not used as abraded (not possible with the methodology used); therefore, qualitative and quantitative information about its potential to wear itself and the evaluated antagonist materials is lacking.

CONCLUSIONS

Based on the findings of this *in vitro* study, the following conclusions were drawn:

1. The nanofilled composite resin and polymer-infiltrated ceramic were the most antagonist-friendly materials when sliding against enamel and any other material.
2. Lithium disilicate, zirconia-reinforced lithium silicate, and zirconia caused high wear rates on the enamel and materials, with the difference that zirconia did not damage the surface of the materials, except for the enamel.
3. Hardness should be considered in the selection of materials, especially in patients with bruxism.

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Corresponding author:

Dr Renata Garcia Fonseca
 Department of Dental Materials and Prosthodontics
 School of Dentistry, São Paulo State University (UNESP)
 Rua Humaitá, 1680, Araraquara, São Paulo 14801-903
 BRAZIL
 Email: renata@foar.unesp.br

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