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Effects of the Finishing Protocols and Oral Hygiene Procedures in the Microhardness and Surface Roughness of CAD/CAM Ceramics

Efectos de los Protocolos de Acabado y Procedimientos de Higiene Orall en la Microdureza y Rugosidad Superficial de las Cerámicas CAD/CAM

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ABSTRACT: The objective of this *in vitro* study was to evaluate the effects of finishing protocols and oral hygiene procedures on the surface and mechanical properties of CAD/CAM ceramics. Specimens (n = 96, (15x10x2mm) of the leucite glass-ceramic (LGC) and feldspathic ceramic (FP) received mechanical polishing or glazing. Surface roughness (Ra) and microhardness (VHN) were obtained with a profilometer and a hardness tester, respectively, before and after each oral hygiene procedure (TB: toothbrushing; PB: prophylaxis with paste and rubber cup; and BJ: prophylaxis with bicarbonate jet). ANOVA, paired t and Tukey's tests were applied (a=0.05). For both materials, only BJ affected Ra's values when mechanical polishing was performed. Moreover, no significant variations in VHN were observed only for LGC glazed with TB. Significant Ra and VHN changes in both materials were observed with BJ. Besides, BJ exhibited similar effects to TB on VHN, regardless of the material and finishing protocol used. Changes in mechanical and surface properties varied with the finishing protocol and the oral hygiene method. In general, prophylaxis with bicarbonate jet was the most harmful method for both materials and the type of finishing protocol did not have a protective effect against changes produced by oral hygiene methods.

KEY WORDS: ceramics, CAD/CAM, polishing, oral hygiene, surface treatment.

INTRODUCTION

Technological advances in restorative dentistry, as well as the great demand of patients for aesthetic treatment, has contributed to the improvement in restorative materials (Hu *et al*., 2020). Present dental ceramics exhibit good aesthetic, biological, mechanical, and functional properties (Pol & Kalk, 2011; Conrad *et al*., 2007). These characteristics vary depending on the material composition (Bajraktarova-Valjakova *et al*., 2018). Among the main advantages of ceramics, their chemical inertness ensures that restorations have a chemically stable surface, do not release potentially harmful elements, and minimize the increase in surface roughness (Ra) and the increase in abrasiveness or susceptibility to bacterial adhesion (Belli *et al*., 2018).

Finishing protocol of ceramics is a strategy employed to reduce the inherent roughness of these materials (Guilardi *et al*., 2019; Abdullah *et al*., 2019; Vasconcellos *et al*., 2006; Preis *et al*., 2012). Mechanical polishing or glazing can be performed, but which technique is better for each material remains unclear (Kanat-Ertürk, 2020; Maciel *et al*., 2019; Kurt *et al*., 2020; Alencar-Silva *et al*., 2019; Yilmaz & Ozkan, 2010; Alencar *et al*., 2022). Regardless of the material used in a restoration, it is subject to degradation and wear processes by various factors (Ludovichetti *et al*. 2018; Joshi *et al*., 2014; Kusuma Yulianto *et al*., 2019), such as chewing and daily oral hygiene procedures (Flury *et al*., 2017; Yuan *et al*., 2018).

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Clinical longevity and aesthetics are dependent on the mechanical properties of restorative materials (Alencar *et al*., 2022; Goujat *et al*., 2018; Spitznagel *et al*., 2018). Previous studies showed that usual oral hygiene methods can degrade the surface of restorative materials and these effects can be dependent on the material composition (Honório *et al*., 2006; Rosentritt *et al*., 2015; Galloway & Pashley, 1987; Soares *et al*., 2010; Samra *et al*., 2012; Bollen *et al*., 1997).

In addition, are no scientific basis about what oral hygiene methods are better indicated for each restorative material (Bidra *et al*., 2016; Barbosa *et al*., 2012). The effects of these different methods on the mechanical and surface properties of indirect restorative materials should be clarified. Thus, this study aimed to analyze the mechanical and surface properties of CAD/CAM ceramics that received different finishing protocols and were submitted to various oral hygiene methods. The null hypotheses that (1) different external finishing protocols or (2) oral hygiene procedures have no effect on the microhardness and surface roughness of the evaluated materials were tested.

MATERIAL AND METHOD

This *in vitro* study evaluated two CAD/CAM ceramic materials: Leucite glass-ceramic [IPS Empress CAD (Ivoclar Vivadent AG)] and Feldsphatic Ceramic [CEREC Blocs (Dentsply Sirona)]. The sample size (n = 8/group) was defined using the G* Power 3.1.9 software (Faul *et al*., 2007) considering a minimum effect size of 45% - (roughness or microhardness) for the outcomes (Maciel *et al*., 2019), 80% statistical power, and 5% significance level. Specimens (15mm x 10mm x 2mm) were obtained from CAD/CAM ceramics blocks by using a cutting machine (Isomet 4000, Buehler, Lake Bluff, IL, USA) with Buehler diamond discs under refrigeration. In sequence, the specimens were randomized to receive mechanical polishing or glazing. Surface finishing and polishing were carried out with an automatic polishing machine (Metaserv 2000, Buehler, Lake Bluff, IL, USA) following a sequence of grift silicon carbide papers (3M ESPE, St. Paul, MN, USA) #360, #400, #600, #800, and #1200 (30 s per grift). The samples were washed in an ultrasound (Boekel Analog Model 139400, PA, USA) with distilled water for 15 min and then dried at room temperature. Glazing was performed by applying a thin layer to the samples, which were heated in a specific oven according to the manufacturer's instructions.

The specimens were randomly divided into three groups (n = 8/material) based on the oral hygiene procedures:

1. TB - toothbrushing: Toothbrushing was carried out on a brushing simulation machine (Odeme Dental Research, Brazil) programmed to perform 80,000 cycles, simulating 5 years. The brushing system, which involved a machine that had an internal ambient temperature of 370 ºC, was operated at a frequency of 2 Hz. Middle toothbrushes were used (Regular Regular TEK, Johnson & Johnson Ind.Com.Ltda., SJdos Campos, São Paulo, Brazil). A solution was prepared with a dentifrice (Colgate Total 12 Clean Mint, Colgate-Palmolive Company, Sao Paulo, SP, Brazil) and distilled water to immerse the specimens during brushing.

2. PR - prophylaxis with prophylaxis paste and rubber cup: Prophylaxis with a rubber cup and oil-free prophylactic paste (Shine, Maquira; Maringá, Brazil) coupled to a low-speed micromotor (Dabi Atlante, Ribeirão Preto, Brazil) was performed for 20 s.

3. BJ - prophylaxis with bicarbonate jet: Specimens were subjected to prophylaxis carried out with a Profi Neo appliance (Dabi Atlante, Ribeirão Preto, Brazil) and Polident sodium bicarbonate powder (Polidental). The tip of the apparatus was positioned at an angle of 90º and 5.0 mm away from the specimen surface for 20 s.

After oral hygiene methods were performed, all specimens were again washed in an ultrasonic bath with distilled water for 15 min and dried at room temperature based on previous property measurements.

Three readings of Ra were performed using a digital profilometer (Mytutoyo Corporation, Tokyo, Japan; Model SJ 400), and the means were determined as the Ra (m) value. The reading accuracy of the profilometer was 0.01 m, the reading length was 2.4 mm, the active tip velocity was 0.5 mm/s, and the radius of the active tip was 5 m.

The surface microhardness was assessed using a hardness tester equipped with a Vickers diamond indenter. Five indentations were made in each specimen under 20 N load and a 20 s dwell time. Vickers hardness number (VHN) was calculated with the following equation: H=P/2d2, where P is the load in Newton, and d is the average of diagonal values. The Ra and VHN were measured before and after the oral hygiene methods.

Data from all response variables were evaluated for the presence of outliers (Tukey's method), the assumption of normality (Shapiro–Wilk test), and homoscedasticity (Levene test). Ra and microhardness data were submitted to two-way ANOVA. Normality was confirmed in all cases (p≥.061). The Tukey's test was performed when significant differences were detected by ANOVA. Paired t-test was applied to show differences in the evaluated parameters with each oral hygiene method. A p-value less than .05 was determined to indicate statistical significance. SPSS version 22.0 (IBM) was used for data analysis.

RESULTS

The results of 2-way ANOVA (Table I) demonstrated that finishing protocol influenced the variations in Ra (p = .002 - FP; p<.001 - LGC) and microhardness (p<.001 for both materials). The influence of oral hygiene methods on Ra was observed only for LGC (p=.043), and oral hygiene methods did not influence the microhardness for any material. Furthermore, the interaction among the tested factors was not significant only for Ra in the LGC group (p=.447). A comparison of the effect after different oral hygiene methods for both glazed and polished groups is presented in the Table II.

A significant difference in Ra variation was observed between the polished and glazed groups in both materials when BJ was performed. For the LGC groups, Ra variations also differed with TB. For the FP group, the finishing protocols significantly influenced microhardness variations. In the groups with mechanical polishing, TB was the procedure that promoted a high reduction, similar to BJ. PR promoted decreased microhardness when glazing was performed, whereas the other procedures promoted increased microhardness.

In the LGC group with mechanical polishing, nonsignificant effects of oral hygiene methods were observed in the variations in microhardness. However, when glazing was performed, PR decreased microhardness, similar to the effects of TB. In addition, increases in VHN were observed in BJ.

Table I. Two-way ANOVA results for comparison of surface roughness and microhardness.

Parameter	Feldsphatic Ceramic		Leucite Glass Ceramic	
	F*	p†	F*	p†
Surface Roughness				
Oral hygiene procedures (OHP)	0.047	.954	3.394	.043[a]
Finishing protocol (FP)	10.532	.002[a]	60.068	<0.001[a]
OHP X FP	7.532	.002[a]	0.820	.447
Microhardness				
Oral hygiene procedures (OHP)	2.298	.113	1.569	.220
Finishing protocol (FP)	154.265	<0.001[a]	67.267	<0.001[a]
OHP X FP	13.732	<0.001[a]	7.303	.002[a]

*F - multifactorial; † 2-way ANOVA; a significative statistically (a=0.05).

Table II. Mean results ±standard deviation and post hoc comparisons for variation in surface roughness (Ra) and microhardness (VHN).

Parameter	*Feldsphatic Ceramic*		*Leucite Glass Ceramic*	
	Polishing	Glaze	Polishing	Glaze
Ra				
TB*	-0.02 ±0.02[Aa]	-0.01 ±0.04[Aa]	-0.01 ±0.02[Ba]	-0.11 ±0.06[Aa]
PR†	0.01 ±0.19[Aa]	-0.02 ±0.08[Aa]	0.01 ±0.02[Aa]	-0.07 ±0.01[Aa]
BJ‡	0.05 ±0.01[Ba]	-0.07 ±0.06[Aa]	0.03 ±0.01[Ba]	-0.08 ±0.04[Aa]
VHN				
TB*	-122.31 ±35.88[Aa]	26.16 ±24.45[Bb]	-63.82 ±44.19[Aa]	-8.14 ±24.51[Bab]
PR†	-65.03 ±38.97[Ab]	-17.37 ±14.70Ba	-52.33 ±34.33[Aa]	-22.43 ±14.38[Aa]
BJ‡	-84.24 ±35.33Aa[b]	29.76 ±12.39[Bb]	-72.37 ±9.39[Aa]	27.18 ±6.93[Bb]

*TB: toothbrushing; †PR: prophylaxis with prophy paste and rubber cup; ‡BJ: prophylaxis with bicarbonate jet. In the same parameter and material, different uppercase letters (horizontally) and different lowercase letters (vertically) denote mean significantly different (p-value <.05).

Table III shows the mean results for Ra and VHN after different oral hygiene methods. For both materials, when mechanical polishing was performed, only BJ affected Ra. BJ also was the only procedure that affected the FP glazed group. However, for the LGC glazed group, all oral hygiene methods decreased Ra. When TB was performed, no significant variations were found in the VHN values only for the LGC glazed group.

Table III. Mean ±standard deviation for surface roughness (Ra) and microhardness (VHN) before and after oral hygiene methods.

Parameter	*Feldsphatic Ceramic*			*Leucite Glass Ceramic*		
	Baseline	After	p-value[a]	Baseline	After	p-value[a]
Ra						
Polishing						
TB*	0.15 ±0.02	0.13 ±0.01	.076	0.15 ±0.03	0.14 ±0.02	.346
PR†	0.14 ±0.02	0.15 ±0.02	.385	0.16 ±0.04	0.16 ±0.04	.757
BJ‡	0.12 ±0.03	0.17 ±0.03	<0.001	0.18 ±0.02	0.21 ±0.03	<0.001
Glaze						
TB*	0.49 ±0.11	0.48 ±0.07	.687	0.49 ±0.08	0.37 ±0.05	.001
PR†	0.49 ±0.11	0.46 ±0.08	.506	0.49 ±0.08	0.42 ±0.06	.019
BJ‡	0.49 ±0.08	0.42 ±0.05	.018	0.48 ±0.05	0.40 ±0.04	<0.001
VHN						
Polishing						
TB*	461.94 ±35.87	339.62 ±13.84	<0.001	413.34 ±24.59	349.52 ±41.49	.005
PR†	457.55 ±46.62	397.45 ±23.09	.009	407.66 ±26.21	355.33 ±28.09	.004
BJ‡	423.18 ±22.21	338.94 ±26.09	<0.001	424.95 ±16.29	352.58 ±17.78	<0.001
Glaze						
TB*	292.80 ±16.32	318.96 ±10.99	.019	328.29 ±16.67	320.15 ±13.66	.379
PR†	300.62 ±16.24	283.25 ±16.95	.012	329.04 ±16.66	306.61 ±14.28	.003
BJ‡	297.17 ±9.87	326.93 ±6.63	<0.001	323.37 ±16.74	350.55 ±14.34	<0.001

*TB: toothbrushing; †PR: prophylaxis with prophy paste and rubber cup; ‡BJ: prophylaxis with bicarbonate; a Paired t test.

DISCUSSION

Finishing protocols are essential for finalizing restorative procedures with ceramics. The literature remains inconclusive on the superiority of mechanical polishing or glazing on the surface and mechanical properties of ceramics (Alencar *et al*., 2022). Besides, the possible clinical implications of oral hygiene methods depending on the surface treatment performed remain unclear. In this study, the effects of finishing protocols on the surface and micromechanical properties exposed to different oral hygiene methods were analyzed. Our results demonstrated that some oral hygiene methods promoted more changes than others. Furthermore, these changes were dependent on the material and finishing protocol. Thus, the null hypotheses were rejected.

Mechanical polishing and glazing are two external surface procedures used in ceramic restorations (Preis *et al*., 2012; Kurt *et al*., 2020; Alencar-Silva *et al*., 2019). Polishing removes traces of milling and scratches on the surface to reduce roughness (Bollen *et al*., 1997). Thus, polishing is considered a reduction process. By contrast, glazing consists of applying a thin fluid layer to the surface, making it an addition process (Vasconcellos *et al*., 2006). The superiority of one of the finishing protocols in obtaining enhanced surface smoothness or mechanical properties is unclear (Kanat-Ertürk, 2020; Maciel *et al*., 2019; Kurt *et al*., 2020; Alencar-Silva *et al*., 2019; Yilmaz & Ozkan, 2010; Alencar *et al*., 2022).

In this study, the effects of the performed finishing protocols on changes in the properties observed varied among the materials and oral hygiene methods. In terms of hardness, the effect of finishing protocol was not significant only for LGC submitted to PR. However, for roughness, finishing protocol altered the effects of BJ for all materials and the performance of TB on LGC. Performance differences for BJ with different finishing protocols may be justified by the protective effect of glazing on air abrasion (Kanat-Ertürk, 2020; Maciel *et al*., 2019; Kurt *et al*., 2020; Alencar-Silva *et al*., 2019). The effects of this procedure on the properties of restorative materials remain unclear, and further studies are needed.

The effects of different hygiene procedures on the surface properties of direct restorative materials and the enamel are reported in the literature (Honório *et al*., 2006; Rosentritt *et al*., 2015; Galloway & Pashley, 1987; Soares *et al*., 2010; Samra *et al*., 2012). In the direct restorative materials, BJ appears to be effective in removing pigments, increasing the longevity of restorations (Samra *et al*., 2012). In enamel, BJ has no deleterious effect on surface properties (Honório *et al*., 2006; Galloway & Pashley, 1987). However, our results demonstrated that BJ had deleterious effects on the mechanical and surface properties of the evaluated ceramics. Similar roughness variations were found for each material when the same finishing protocol was performed, regardless of the oral hygiene methods conducted. However, hardness variations were affected by oral hygiene methods.

Variations in mechanical and surface properties of ceramics with BJ were dependent on the finishing protocol. In polished materials, BJ caused abrasion and increased roughness. In the groups that received glazing, the opposite effect was observed, resulting in high smoothness. There are no reports in the literature to support these results. However, sodium bicarbonate particles are believed to cause an abrasion on the ceramic surface. Thus, the abrasion may reverse mechanical polishing, justifying an increase in Ra in the groups that received this finishing protocol.

At the best level of knowledge of the authors, this study is the first to report the effects of the oral hygiene procedures commonly observed in clinical practice on the surface and mechanical properties of ceramics that received different finishing protocols. Our results suggested that hygiene procedures should consider the properties of the restorative material used and the finishing protocol performed to ensure the longevity of restorative procedures.

There are limitations to this *in vitro* study. The oral hygiene methods with parameters applied to simulate in vivo conditions could not reproduce the dynamic oral environment, such as changes in pH, masticatory forces, and the presence of bacteria and saliva. Furthermore, the uniform flat surface of the specimen may lead to behavior that differs from the curved contours of crowns. However, no standardized protocol has been established to correspond with the physiological oral environment. Therefore, future studies that include additional parameters are needed for in vivo simulations, and their impact on the clinical longevity of restorative materials should be clarified.

The main findings of this study show that different finishing protocols promoted different roughness and microhardness variations to different oral hygiene methods. The longevity of ceramic restorations seems to be dependent on the finishing protocol and oral hygiene methods. Knowing the deleterious effects arising from the association of finishing protocol with oral hygiene methods are fundamental for clinical decision making.

CONCLUSION

Within its limitations, it can be concluded that CAD/CAM ceramics that receive different finishing protocols present different variations to different hygiene methods. Bicarbonate jet prophylaxis seems to be the hygiene method most deleterious to the properties of the tested ceramics, regardless of whether they receive mechanical polishing or glaze. Besides, greater variations in microhardness, regardless of the hygiene method, were observed for ceramics that received mechanical polishing. Therefore, the success of ceramics restorations can vary depending on the finishing protocol and oral hygiene method. The most suitable oral hygiene method should be determined by the clinician according to the finishing protocol and CAD / CAM ceramic used.

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RESUMEN: El objetivo de este estudio *in vitro* fue evaluar los efectos de los protocolos de acabado y los procedimientos de higiene oral sobre la superficie y las propiedades mecánicas de las cerámicas CAD/CAM. Los especímenes (n = 96, (15x10x2mm) de vitrocerámica de leucita (LGC) y cerámica feldespática (FP) recibieron pulido mecánico o glaseado. La rugosidad de la superficie (Ra) y la microdureza (VHN) se obtuvieron con un perfilómetro y un probador de dureza, respectivamente, antes y después de cada procedimiento de higiene oral (TB: cepillado dental; PB: profilaxis con pasta y vaso de hule; y BJ: profilaxis con chorro de bicarbonato). Se aplicaron ANOVA, t pareada y prueba de Tukey (a=0.05). Para ambos materiales, solo BJ afectó los valores de Ra cuando se realizó el pulido mecánico. Además, no se observaron variaciones significativas en VHN solo para LGC vidriado con TB. Se observaron cambios significativos de Ra y VHN en ambos materiales con BJ. Además, BJ exhibió efectos similares a TB en VHN, independientemente del material y protocolo de acabado utilizado Los cambios en las propiedades mecánicas y superficiales variaron con el protocolo de acabado y el método de higiene oral. En general, la profilaxis con chorro de bicarbonato fue el método más perjudicial, tanto los materiales como el tipo de protocolo de acabado no tuvieron un efecto protector frente a los cambios producidos por los métodos de higiene oral.

PALABRAS CLAVE: cerámica, CAD/CAM, pulido, higiene oral, tratamiento de superficies.

REFERENCES

Abdullah, A. O.; Hui, Y.; Sun, X.; Pollington, S.; Muhammed, F. K. & Liu Y. Effects of different finishing protocols on the shear bond strength of veneering ceramic materials to zirconia. *J. Adv. Prosthodont., 11(1)*:65-74, 2019.

Alencar-Silva, F. J.; Barreto, J. O.; Negreiros, W. A.; Silva, P. G. B.; Pinto-Fiamengui, L. M. S. & Regis R. R. Effect of beverage solutions and toothbrushing on the surface roughness; microhardness; and color stainability of a vitreous CAD-CAM lithium disilicate ceramic. *J. Prosthet. Dent., 121(4)*:711.e1-711.e6, 2019.

Alencar, C. M.; Zaniboni, J. F.; Silva, A. M.; Ortiz, M.; Lima, D. & de Campos, E. A. Impact of Finishing Protocols on Color Stability of CAD/CAM Ceramics: A Systematic *Review. Int. J. Prosthodont., 35(1)*:109-18, 2022.

Bajraktarova-Valjakova, E.; Korunoska-Stevkovska, V.; Kapusevska, B.; Gigovski, N.; Bajraktarova-Misevska, C. & Grozdanov, A. Contemporary Dental Ceramic Materials; A Review: Chemical Composition; Physical and Mechanical Properties; Indications for Use. *Open Access Maced. J. Med. Sci., 6(9)*:1742–55, 2018.

Barbosa, R.P.; Pereira-Cenci, T.; Silva, W.M.; Coelho-de-Souza, F.H.; Demarco, F.F. & Cenci M.S. Effect of cariogenic biofilm challenge on the surface hardness of direct restorative materials *in situ. J. Dent., 40(5)*:359-63, 2012.

Belli, R.; Wendler, M.; Zorzin, J. I. & Lohbauer, U. Practical and theoretical considerations on the fracture toughness testing of dental restorative materials. *Dent. Mater., 34(1)*:97-119, 2018.

Bidra, A. S.; Daubert, D. M.; Garcia, L. T.; *et al*. A Systematic Review of Recall Regimen and Maintenance Regimen of Patients with Dental Restorations. Part 1: Tooth-Borne Restorations. J. *Prosthodont., 25(1)*:S2–15, 2016.

Bollen, C. M.; Lambrechts, P. & Quirynen, M. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. *Dent. Mater., 13(4)*:258-69, 1997.

Conrad, H. J.; Seong, W. J. & Pesun I. J. Current ceramic materials and systems with clinical recommendations: a systematic review. *J. Prosthet. Dent., 98(5)*:389-404, 2007.

Faul, F.; Erdfelder, E.; Lang, A. G. & Buchner, A. G*Power 3: a flexible statistical power analysis program for the social; behavioral; and biomedical sciences. *Behav. Res. Methods., 39(2)*:175-91, 2007.

Flury, S.; Diebold, E.; Peutzfeldt, A. & Lussi A. Effect of artificial toothbrushing and water storage on the surface roughness and micromechanical properties of tooth-colored CAD-CAM materials. *J. Prosthet. Dent., 117(6)*:767–774, 2017.

Galloway, S. E. & Pashley, D. H. Rate of removal of root structure by the use of the Prophy-Jet device. *J. Periodontol., 58*:464-9, 1987

Goujat, A.; Abouelleil, H.; Colon, P.; *et al*. Mechanical properties and internal fit of 4 CAD-CAM block materials. *J. Prosthet. Dent., 119(3)*:384-9, 2018.

Guilardi, L. F.; Soares, P.; Werner, A. *et al*. Fatigue performance of distinct CAD/CAM dental ceramics. *J. Mech. Behav. Biomed. Mater., 103*:103540, 2020.

Honório, H. M.; Rios, D.; Abdo, R. C. & Machado M. A. Effect of different prophylaxis methods on sound and demineralized enamel. *J. Appl. Oral. Sc., 14(2)*:117-23, 2006.

Hu, M. L.; Lin, H.; Zhang, Y. D. & Han, J. M. Comparison of technical, biological, and esthetic parameters of ceramic and metal-ceramic implant-supported fixed dental prostheses: A systematic review and meta-analysis. *J. Prosthet. Dent., 124(1)*:26-35.e2, 2020.

Joshi, G. V.; Duan, Y.; Della Bona, A.; Hill, T.J.; St John, K. & Griggs J.A. Contributions of stress corrosion and cyclic fatigue to subcritical crack growth in a dental glass-ceramic. *Dent. Mater., 30(8)*:884-90, 2014.

Kanat-Ertürk, B. Color Stability of CAD/CAM Ceramics Prepared with Different Surface Finishing Procedures. *J. Prosthodont., 29(2)*:166-72, 2020.

Kurt, M.; Bankoglu Güngör, M.; Karakoca Nemli, S. & Turhan Bal, B. Effects of glazing methods on the optical and surface properties of silicate ceramics. *J. Prosthodont. Res., 64(2)*:202-9, 2020.

Kusuma Yulianto, H. D.; Rinastiti, M.; Cune M. S.; *et al*. Biofilm composition and composite degradation during intra-oral wear. *Dent. Mater., 35(5)*:740-50, 2019.

Ludovichetti, F. S.; Trindade, F. Z.; Werner, A.; Kleverlaan, C.J. & Fonseca R.G. Wear resistance and abrasiveness of CAD-CAM monolithic materials. *J. Prosthet. Dent., 120(2)*:318.e1–8, 2018.

Maciel, L. C.; Silva, C. F. B.; de Jesus, R. H.; Concílio, L. R. D. S.; Kano, S. C. & Xible A. A. Influence of polishing systems on roughness and color change of two dental ceramics. *J. Adv. Prosthodont., 11(4)*:215–222, 2019.

Pol, C. W. & Kalk W. A systematic review of ceramic inlays in posterior teeth: an update. *Int. J. Prosthodont., 24(6)*:566-75, 2011.

Preis, V.; Behr, M.; Handel, G.; Schneider-Feyrer, S.; Hahnel S. & Rosentritt M. Wear performance of dental ceramics after grinding and polishing treatments. *J. Mech. Behav. Biomed Mater., 10*:13-22, 2012.

Rosentritt, M.; Sawaljanow, A.; Behr, M.; Kolbeck, C. & Preis V. Effect of toothbrush abrasion and thermo-mechanical loading on direct and indirect veneer restorations. *Clin. Oral. Investig., 19(1)*:53-60, 2015.

Samra, A. P.; Ribeiro, D. G.; Borges, C. P. & Kossatz S. Influence of professional prophylaxis on reducing discoloration of different aesthetic restorative materials. *J. Dent., 40(2)*:e71-6, 2012.

Soares, P. B.; Magalhães, D.; Fernandes Neto, A. J.; Castro, C.G.; Santos Filho, P.C. & Soares C.J. Effect of periodontal therapies on indirect restoration: a scanning electron microscopic analysis. *Braz. Dent. J., 21(2)*:130-6, 2010.

Spitznagel, F. A.; Scholz, K. J.; Strub, J. R.; Vach, K. & Gierthmuehlen P. C. Polymer-infiltrated ceramic CAD/CAM inlays and partial coverage restorations: 3-year results of a prospective clinical study over 5 years. *Clin. Oral. Investig., 22(5)*:1973-83, 2018.

Vasconcellos, B. T.; Miranda-Júnior, W. G.; Prioli, R.; Thompson, J.; Oda, M. Surface roughness in ceramics with different finishing techniques using atomic force microscope and profilometer. *Oper. Dent., 31(4)*:442-9, 2006.

Yilmaz, K. & Ozkan, P. Profilometer evaluation of the effect of various polishing methods on the surface roughness in dental ceramics of different structures subjected to repeated firings. *Quintessence Int., 41(7)*:e125–e31, 2010.

Yuan, J. C.; Barão, V. A. R.; Wee, A. G.; Alfaro, M. F.; Afshari, F. S. & Sukotjo C. Effect of brushing and thermocycling on the shade and surface roughness of CAD-CAM ceramic restorations. J *Prosthet. Dent., 119(6)*:1000-6, 2018.

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