Surface roughness and microhardness of conventional and CAD/CAM resins subjected to different polishing systems and to erosive-abrasive challenge

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INTRODUCTION

- The growing prevalence of erosive tooth wear is apparently associated with lifestyle and dietary habits and has stepped up the search for preventive and restorative measures.
- Resin composites have been widely used in cases in which tooth structure loss is caused by erosive tooth wear.
- Quite recently, technological breakthroughs aimed at making clinical practice easier have led to the development of resin composites available as CAD/CAM blocks, expanding the use of resin composites in indirect restorations.
- The final surface smoothness of restorations made with resin composite, obtained through finishing and polishing procedures, has been identified as one of the determinants of their longevity.

OBJECTIVES

- The aim of this in vitro study was to evaluate the effects of erosive-abrasive challenge and polishing systems on the surface roughness and microhardness of conventional and CAD/CAM resin composites.

METHODS & MATERIAL

Study design

A randomized laboratory study of the following factors was conducted: a) type of resin – either conventional or CAD/CAM; b) polishing system: polishing disc or disc + diamond polisher, and c) assessment period: before or after the erosive-abrasive challenge. The response variables were surface roughness (Ra) and Vickers hardness number (VHN).

Table 1. Materials used in the study

MATERIAL	MANUFACTURER	DESCRIPTION
Grandio blocs	VOCO GmbH, Cuxhaven, Germany	Nanohybrid composite blocks for CAD/CAM milling
GrandioSO	VOCO GmbH, Cuxhaven, Germany	Nanohybrid composite
Sof-Lex Pop	3M Oral Care - Maplewood, Minnesota, USA	Polishing disc
Dimanto	VOCO GmbH, Cuxhaven, Germany	Diamond polisher

- Specimens of Grandio blocs and GrandioSO were made with a thickness of 2mm.
- The specimens obtained from each material were randomized into two polishing systems:
  Polishing discs (Sof-lex pop on), or polishing discs + diamond polisher (Dimanto) (n=8).
- The erosive-abrasive challenge was performed for 5 days, with four daily cycles, alternating between 0.3% citric acid solution (5min) and brushing (45 cycles/15 s) in a toothbrushing machine.
- Surface roughness and microhardness were assessed before and after the erosive-abrasive challenge with roughness meter and Vickers microhardness tester, respectively.
- Surface topography was assessed by scanning electron microscopy (QuantaTM 250 SEM, Oregon, USA) equipped with INCA software (Oxford Instruments Analytical, UK) at 5000X magnification.
- Repeated-measures analysis of variance (ANOVA) and Bonferroni were applied for data analysis (α=0.05).

RESULTS

SURFACE ROUGHNESS

Table 2. Mean and standard deviation obtained for surface roughness (Ra - µm) of conventional and CAD/CAM resin composites subjected to different surface treatments and to erosive-abrasive challenge.

Material	Surface treatment	Baseline	After erosive-abrasive challenge
Conventional resin composite (GrandioSO)	Polishing disc	0.35 ±0.11$_b$	0.24 ±0.03$_a$
	Polishing disc + diamond polisher	0.26 ±0.07$_a$	0.19 ±0.06$_a$
CAD/CAM resin composite (Grandio blocs)	Polishing disc	0.12 ±0.02$_a$	0.23 ±0.04$_b$
	Polishing disc + diamond polisher	0.27 ±0.06$_a$	0.23 ±0.04$_a$

Comparisons were made at the same line, $^{a-b}$ Different lowercase letters indicate statistically significant difference (Bonferroni, p≤0.024).

MICROHARDNESS

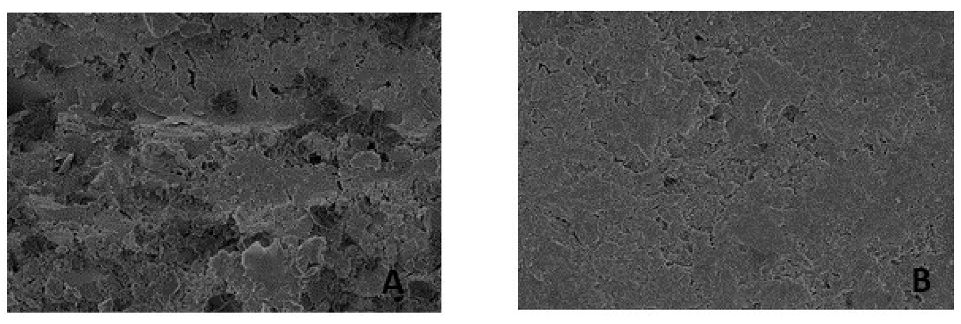
Table 3. Mean and standard deviation obtained for Vickers hardness number (VHN) of conventional and CAD/CAM resin composites subjected to different surface treatments and to the erosive-abrasive challenge.

Material	Surface treatment	Baseline	After erosive-abrasive challenge
Conventional resin composite (GrandioSO)	Polishing disc	116.21 ±13.53$_a$	121.72 ±10.41$_a$
	Polishing disc + diamond polisher	125.31 ±13.48$_a$	135.31 ±10.39$_a$
CAD/CAM resin composite (Grandio blocs)	Polishing disc	115.15 ±12.76$_a$	129.31 ±9.43$_a$
	Polishing disc + diamond polisher	142.22 ±12.29$_a$	148.03 ±9.86$_a$

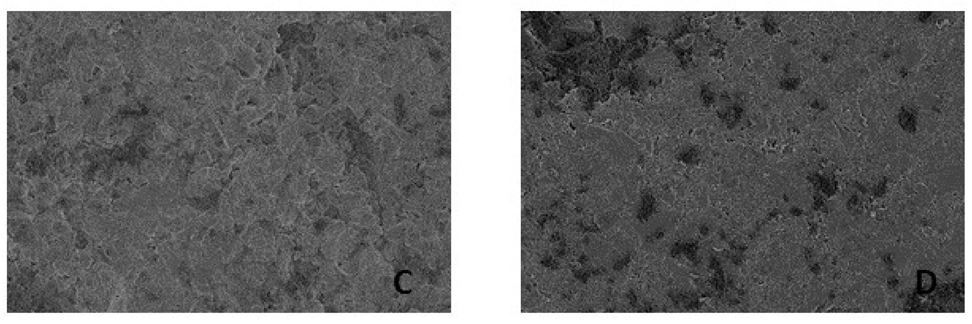
Comparisons were made at the same line, $^{a-b}$ Different lowercase letters indicate statistically significant difference (Bonferroni, p≤0.016).

SURFACE TOPOGRAPHY

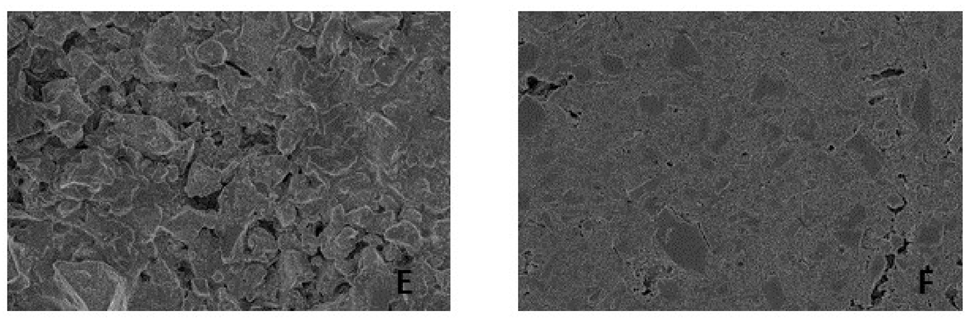
Surface topography was assessed by scanning electron microscopy (SEM) and revealed wear on the surface after the erosive-abrasive challenge.



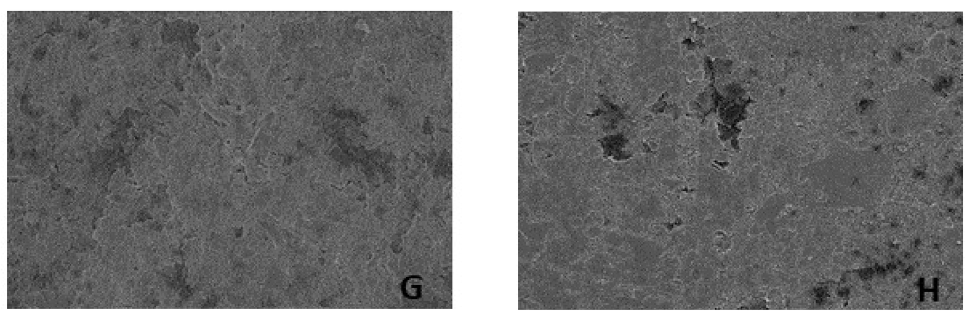
CAD/CAM resin polished with polishing disc before (A) and after (B) erosive-abrasive challenge.



CAD/CAM resin polished with polishing disc + diamond polisher before (C) and after (D) erosive-abrasive challenge.



Conventional resin polished with polishing disc before (E) and after (F) erosive-abrasive challenge.



Conventional resin polished with polishing disc + diamond polisher before (G) and after (H) erosive-abrasive challenge.

DISCUSSION

- Our study demonstrated that polishing disc + diamond polisher provides a smoothness pattern for conventional resin composite.
- The use of only polishing discs on CAD/CAM resin promoted a smoother surface condition probably by cutting with efficiency the filling particles on the resin.
- When the diamond polisher was applied on CAD/CAM resins an increase on Ra values were observed. The manufacturer of the diamond polisher suggests that by changing the amount of pressure exerted, it can determine the abrasion performance of the polisher.
- Acid challenge can cause erosion on the resin surface which, when combined with toothbrushing immediately thereafter, can potentially wear down the resin surface, eventually making it smoother.
- When the same material was subjected to the same surface treatment, the erosive-abrasive challenge did not cause significant changes in microhardness, and the probable explanation to that lies with the concentration and pH of the citric acid used in our study.

CONCLUSION

- The erosive-abrasive challenge influenced the surface roughness of the tested materials.
- Considering the same resins and polishing systems, microhardness values had no statistical difference when materials were subjected to erosive-abrasive challenge.

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