



Effect of Water Flossing and Manual Flossing on Color Stability and Surface Roughness of Zirconia and Lithium Disilicate: An In Vitro Study

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KEYWORDS

CAD/CAM,
Water Flosser
Surface Roughness
Colour Stability

ABSTRACT:

Introduction: Maintenance of surface integrity and color stability is essential for the long-term esthetics of ceramic restorations. Water flossers, as an emerging adjunct to conventional oral hygiene, may influence the surface characteristics of dental materials.

Objectives: To evaluate the effects of water flossing and manual flossing on the surface roughness and color stability of zirconia and lithium disilicate.

Methods: 30 CAD/CAM milled samples (15 zirconia, 15 lithium disilicate) were assigned into three subgroups per material: water flosser, manual floss, and control (n=5 each). Profilometer and digital spectrophotometer were used to record surface roughness and color (ΔE) before and after intervention. Water flosser was standardized to 90 psi pressure in pulse mode. ANOVA test was used for statistical analysis ($p < 0.05$).

Results: Water flossing significantly increased surface roughness in both materials, especially lithium disilicate ($\Delta Ra = 1.162 \mu m$). Color change (ΔE) was statistically significant in lithium disilicate after water flossing ($\Delta E = 4, p=0.04$). Manual flossing had minimal impact on zirconia and Lithium disilicate

Conclusions: Water flossing, while effective in plaque control, may compromise ceramic surface integrity. Lithium disilicate showed greater susceptibility to surface degradation than zirconia. Clinical discretion is advised when recommending water flossers for patients with esthetic ceramic restorations.

1. Introduction

An ideal restorative material should replicate the biomechanical and esthetic properties of natural dentition while resisting long-term degradation from oral environmental factors. Among contemporary dental ceramics, lithium disilicate and zirconia stand out for their excellent mechanical strength, translucency, and biocompatibility¹

The color stability and surface roughness of ceramic restorations are paramount to both esthetic outcomes and biofilm control. Increased surface roughness not only compromises gloss and light reflectivity but also enhances plaque accumulation, potentially accelerating wear and discoloration¹.

Surface changes in ceramics can result from various factors including chemical exposure (e.g., beverages, mouthwashes), pH cycling, brushing habits, and notably, oral hygiene aids such as dental floss and water flossers¹.

Water flossers—devices using high-pressure, pulsating water streams—have gained popularity due to improved plaque removal and patient compliance¹. However, their impact on restorative material surfaces is under-investigated. Literature suggests that long-term use of oral irrigators might affect surface texture, particularly in porcelain-based ceramics¹. The null hypothesis states that flossing and manual flossing does not significantly impact surface roughness and colour stability.



This study investigates the comparative impact of manual flossing and water flossing on surface roughness (Ra) and color stability (ΔE) of zirconia and lithium disilicate ceramic materials.

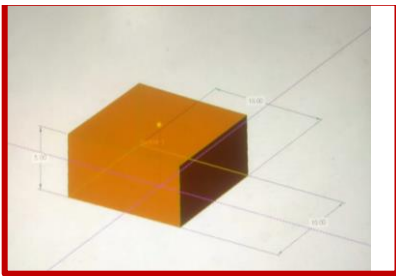


Fig1-STL fiel

Objectives

To evaluate the effects of water flossing and manual flossing on the surface roughness

To evaluate the effects of water flossing and manual flossing on color stability of zirconia and lithium disilicate.

To compare the effects of water flossing and manual flossing on the surface roughness

To compare the effects of water flossing and manual flossing on color stability of zirconia and lithium disilicate

2. Materials & Methods

This was an in vitro experimental study conducted to compare the effects of manual flossing and water flossing on surface roughness and color stability of two commonly used CAD/CAM esthetic prosthetic materials: zirconia and lithium disilicate.

STL fiel dimensions[10*10*3] was generated in CAD software

A total of 30 square blocks (10 × 10 × 3 mm) were milled using wet milling for lithium disilicate in 5 axis milling machine blocks and dry milling for zirconia Disk.



Fig 2-Wet milling [lithium disilicate block]

Prepared zirconia and lithium disilicate sample were sintered in standerd settings and then glazing was done so it simulates crown prosthesis.

Each group was divided into three subgroups (n=5 each): Control, Manual Floss, Water Flosser.

Control group [non-treatment group]

Blocks were mount in putty to simulate interdental contact ,then water flosser [Oracura waterflosser] on 90 psi pulse mode and flossing was done in contact areas for 5 hrs.

Simulates the 10 year effect of flossing and waterflossing, Flossing was standardized using a sliding mechanism, for about 5 hrs Manual flossing[colgate floss] done using spool method about 5hrs

Surface Roughness was measured using a contact profilometer. Color Stability was evaluated using a digital spectrophotometer (Vita Easysshade)

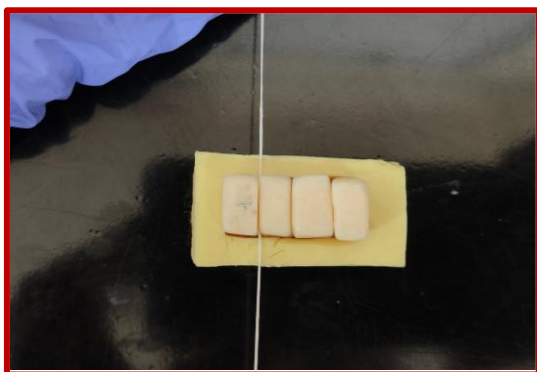


Fig 3-Flossing



Fig 4 – water flossing



Fig 6- profilometer



fig7- vita Easyshade

Statistical Analysis:

Data were analyzed using ANOVA, significance set at $p < 0.05$.

3 Results

SURFACE ROUGHNESS (RA)

Intra-group Comparison:

In Zirconia, Ra increased from 0.6520 μm to 0.6860 μm (manual) and from 0.6640 μm to 1.4580 μm (water flosser). In Lithium Disilicate, values rose from 0.6420 μm to 0.7880 μm (manual) and from 0.6580 μm to 1.8200 μm (water flosser).

	N	Minimum	Maximum	Mean	Slandered Deviation
Control group [zirconia]	5	.64	.67	.6520	.01095
Surface Roughness Flossing (Zirconia)	5	.65	.71	.6860	.02302
Surface Roughness Water Flossing (Zirconia)	5	1.40	1.56	1.458	.06943
Control group (Lithium Disilicate)	5	.61	.66	.6420	.02049
Surface Roughness Flossing (Lithium Disilicate)	5	.68	.88	.7880	.08815
Surface Roughness Water Flossing (Lithium Disilicate)	5	1.70	1.92	1.8200	.09874

**Inter-group Comparison:**

Manual flossing resulted in minimal roughness change: Zirconia ($\Delta Ra = 0.034 \mu m$), Lithium Disilicate ($\Delta Ra = 0.146 \mu m$). Water flossing led to major increases: Zirconia ($\Delta Ra = 0.794 \mu m$), Lithium Disilicate ($\Delta Ra = 1.162 \mu m$). ANOVA $F = 191.609$, $p < 0.001$.

		N	Mean	Std. Deviation	Std. Error Mean	t	P Value
Surface Roughness Flossing (Zirconia)	control	5	.6520	.01095	.00490		
	floss	5	.6860	.02302	.01030	-3.470	.026
Surface Roughness Water Flossing (Zirconia)	control	5	.6640	.03286	.01470		
	Water floss	5	1.4580	.06943	.03105	-23.662	.000
Surface Roughness Flossing (Lithium Disilicate)	control	5	.6420	.02049	.00917		
	floss	5	.7880	.08815	.03942	-3.474	.025
Surface Roughness Water Flossing (Lithium Disilicate)	control	5	.6580	.04207	.01881	-21.166	.000
	Water flossing	5	1.8200	.09874	.04416		

COLOR STABILITY (ΔE)**Intra-group Comparison:**

In Zirconia, ΔE was 0.89 (manual) and 1.59 (water). In Lithium Disilicate, ΔE was 0.07 (manual) and 4.11 (water, $p=0.001$).

Group	N	Mean	Standard Deviation	P-value
Control Zirconia	5	9.96	0.94	
Zirconia + water Floss	5	11.50	0.79	0.08
Zirconia + Floss	5	10.85	1.47	0.73
Control Lithium Disilicate	5	8.39	0.63	—



Lithium Disilicate + Floss	5	8.46	0.57	0.80
Lithium Disilicate + Water Floss	5	12.50	0.45	0.001

Inter-group Comparison:

Highest ΔE was seen in lithium disilicate with water flossing ($\Delta E = 12.50$). Zirconia had $\Delta E = 11.50$. Manual flossing showed minimal change.

Group	N	Mean	Standard Deviation	P-value
Control Zirconia	5	9.96	0.94	
Zirconia + water Floss	5	11.50	0.79	0.08
Zirconia + Floss	5	10.85	1.47	0.73
Control Lithium Disilicate	5	8.39	0.63	—
Lithium Disilicate + Floss	5	8.46	0.57	0.80
Lithium Disilicate + Water Floss	5	12.50	0.45	0.001

Discussion

This study investigated the effects of oral irrigator and dental floss use on current prosthetic restorative materials in terms of changes in surface roughness and colour stability.

The oral irrigator application was standardized using a sliding mechanism by a single applicator, equivalent to a period of 10 years¹.

Nuran yanikoglu reported that for changes in surface properties of feldspathic porcelains and Monolithic zirconium to be observed, a usage period of at least 8–12 years is required¹.

For surface roughness, we used the arithmetic mean height of the surface (Ra), equivalent to the line's arithmetic average height used in most previous surface roughness studies¹.

The study compares the surface roughness (SR) of Zirconia and Lithium Disilicate after treatment with floss and a water flosser.

The results indicate that using a water flosser increases surface roughness more than floss in all materials.

Water flossing significantly increased the colour change in lithium disilicate, suggesting a strong effect on its colour stability.

Water flosser use at 90 psi significantly increased surface roughness in both ceramics, especially in lithium disilicate. This agrees with findings from Yanikoğlu et al. and Zhang et al., who reported hydro-mechanical and physical wear in glass-based ceramics⁵.

Color changes, though not universally significant, were notable in lithium disilicate after water flossing. Increased surface roughness leads to light scattering and stain retention, impacting esthetics as described by Saxena et al. and Garza et al.⁷.

Manual flossing showed minimal impact, reaffirming its safety for ceramic restorations. The 10-year simulation technique lends strength to the findings by replicating long-term effects [9].



Conclusion

Water flossing at 90 psi significantly increases surface roughness of zirconia and lithium disilicate. Lithium disilicate is also vulnerable to esthetic changes due to color shift. Manual flossing is safer for maintaining ceramic restoration integrity. The null hypothesis was rejected.

Clinical Implications

1. Zirconia is more resilient and may be preferred for patients using water flossers.
2. Patients should be educated on correct usage of water flossers, including pressure settings.
3. Esthetic longevity should guide material selection, especially in anterior restorations.

Study Limitations

This in vitro study does not replicate the full complexity of the oral environment. Only one water flosser pressure setting (90 psi) was tested. Only zirconia and lithium disilicate were analyzed.

REFERENCES

- 1] Investigation of the Effect of Waterpik Use on the Surface Properties of Porcelain and Zirconium Materials [research squarehttps://doi.org/10.21203/rs.3.rs-4814513/](https://doi.org/10.21203/rs.3.rs-4814513/)
- 2] Ramy Siam, Gihan Elnaggar and Eman Hassanien. Surface roughness and translucency of glazed lithium disilicate (IPS E.Max) vs. glazed and polished "zirconia-reinforced lithium silicate" (Celtra duo) (in vitro study). *Int. J. Appl. Dent. Sci.* 2021;7(1):251-258. DOI: 10.22271/oral.2021.v7.i1d.1141
- 3] Sharma NC, Lyle DM, Qaqish JG, Galustians J, Schuller R. Effect of a dental water jet with orthodontic tip on plaque and bleeding in adolescent patients with xed orthodontic appliances. *American Journal of Orthodontics and Dentofacial Orthopedics* 2008;133:565-571.
- 4] Saxena A, Wadhawan A, Malik M, Juneja M. Evaluation of colour stability and surface roughness of three CAD/CAM materials (IPS e.max, Vita Enamic, and PEEK) after immersion in two beverage solutions: An in vitro study. *Int J Appl Dent Sci.* 2022;8(1):439-449. doi:10.22271/oral.2022.v8.i1g.1460
- 4] Kalantari MH, Ghoraishian SA, Mohaghegh M. Evaluation of accuracy of shade selection using two spectrophotometer systems: Vita Easyshade and Degudent Shadepilot. *Eur J Dent.* 2017 Apr-Jun;11(2):196-200. doi: 10.4103/ejd.ejd_195_16. PMID: 28729792; PMCID: PMC5502564.
- 5] Zhang W, Yamashita S, Kumazawa T, Ozeki F, Hyuga H, Kita H. influence of surface roughness parameters and surface morphology on friction performance of ceramics. *Journal of the Ceramic Society of Japan* 2019;127(11):837-842.
- 6] Aker DA, Aker JR, Sorensen SE. Toothbrush abrasion of color-corrective porcelain stains applied to porcelain-fused-to-metal restorations. *The Journal of prosthetic dentistry* 1980;44(2):161-163.
- 7] Garza LA, Thompson G, Cho S-H, Berzins DW. Effect of toothbrushing on shade and surface roughness of extrinsically stained pressable ceramics. *The Journal of prosthetic dentistry* 2016;115(4):489-494.