Impact of gastric acidic challenge on surface topography of monolithic zirconia

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Introduction

Can monolithic zirconia withstand attack by gastric acid in bulimic or GERD patients?

Over the last 20 years, dental erosion causes, diagnosis and management has become a topic of interest in general dentistry. (1)

Gastric acid gains access to the oral cavity through vomiting or regurgitation; eating disorders such as anorexia and bulimia nervosa and medical conditions like gastroesophageal reflux disease (GERD). (2)

Eroded teeth can be restored with either direct or indirect restorations. With the increasing demands for esthetic restorations, full-contour monolithic zirconia has gained attention as a suitable material for restoring worn dentitions. (3,4)

However, there has been no study examining the behavior of monolithic zirconia to gastric acid.

Materials and Methods

Monolithic zirconia specimens (Four partially stabilized (PSZ) and one fully stabilized (FSZ)) and IPS e.max CAD (control) were cut (10×10×1.2 mm), sintered, polished and cleaned.

Specimens were immersed in 5 ml of simulated gastric acid solution (hydrochloric acid, 0.06 M, 0.113% solution in deionized distal water, pH 1.2) for 96 hours in a 37°C incubator.

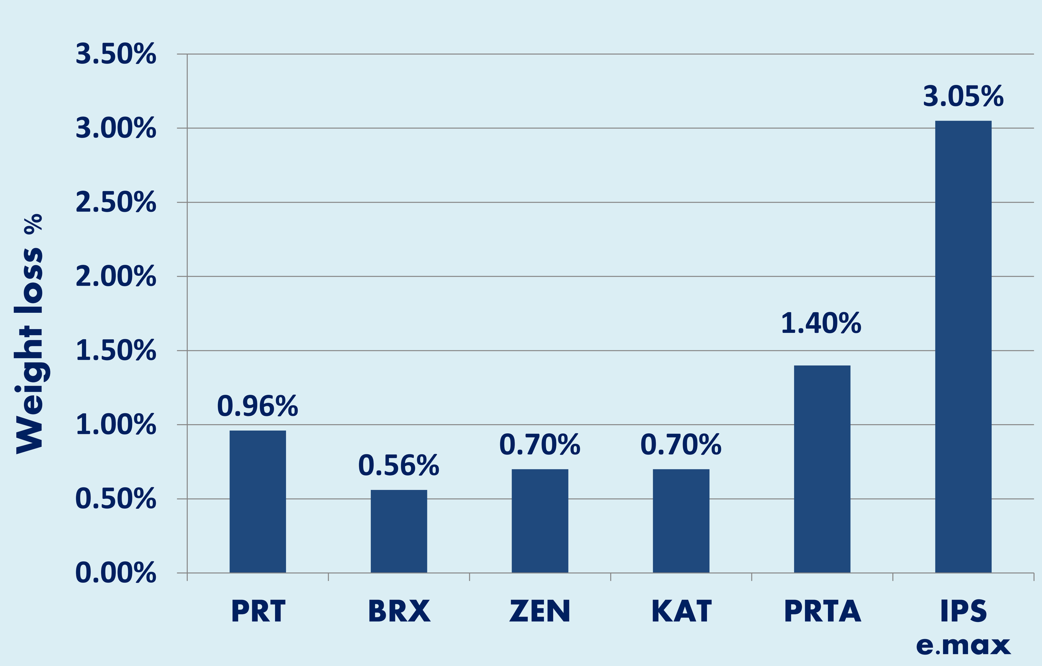
Specimens were weighed and examined for morphological changes under scanning electron microscope (SEM) coupled with energy dispersive x-ray spectroscopy (EDX). Surface roughness was evaluated by a confocal microscope.

The data was analyzed by one-way ANOVA followed by Tukey's HSD post hoc test ($p<0.05$).

Brand name	Code	Manufacturer	Composition
Partially stabilized zirconia (PSZ)			
Prettau Zirconia	PRT	Zirkonzahn, Taufers, Italy	4%–6% Y_2O_3, <1% Al_2O_3, max. 0.02% SiO_2, max. 0.01% Fe_2O_3, max. 0.04% Na_2O
Bruxzir Zirconia	BRX	Glidewell Laboratories, Irvine, USA	Unknown
Wieland Zenostar Translucent	ZEN	Ivoclar Vivadent, Principality of Liechtenstein	Unknown
Katana High Translucent	KAT	Kurary Noritake INC, Noritake, Japan	(ZrO_2 + HfO_2 + Y_2O_3) > 99.0 %, yttrium oxide (Y_2O_3) > 4.5 – <= 6.0 %,hafnium oxide (HfO_2) <= 5.0 %, other oxides <= 1.0 %
Fully stabilized zirconia (FSZ)			
Prettau Anterior	PRTA	Zirkonzahn, Taufers, Italy	<12% Y_2O_3, <1% Al_2O_3, max. 0.02% SiO_2, max. 0.01% Fe_2O_3, max. 0.04% Na_2O
Control			
IPS e.max CAD	IPS e.max	Ivoclar Vivadent AG, Schaan, Liechtenstein	SiO_2 in addition to Li_2O, K_2O, MgO, Al_2O_3, P_2O_5 and other oxides.

Results

Weight loss of the specimens after acid immersion.



Mean values and standard deviation (SD) of S_a and S_q (μm) measurements before and after acid immersion.

Groups	S_a		S_q	
	Before	After	Before	After
PRT	0.009 (0.002)	0.008 (0.001)	0.011 (0.001)	0.010 (0.001)
BRX	0.009 (0.003)	0.008 (0.002)	0.011 (0.002)	0.008 (0.001)
ZEN	0.012 (0.001)	0.007 (0.002)*	0.015 (0.002)	0.012 (0.004)*
KAT	0.009 (0.001)	0.008 (0.001)	0.014 (0.002)	0.012 (0.003)
PRTA	0.013 (0.002)	0.008 (0.002)*	0.021 (0.004)	0.011 (0.003)*
IPS e.max	0.011 (0.002)	0.014 (0.001)*	0.017 (0.003)	0.022(0.002)*

* *Significantly lower S_a/S_q (reduced surface roughness) after acid immersion.*

Surface elements (atom %) of specimens after acid immersion.

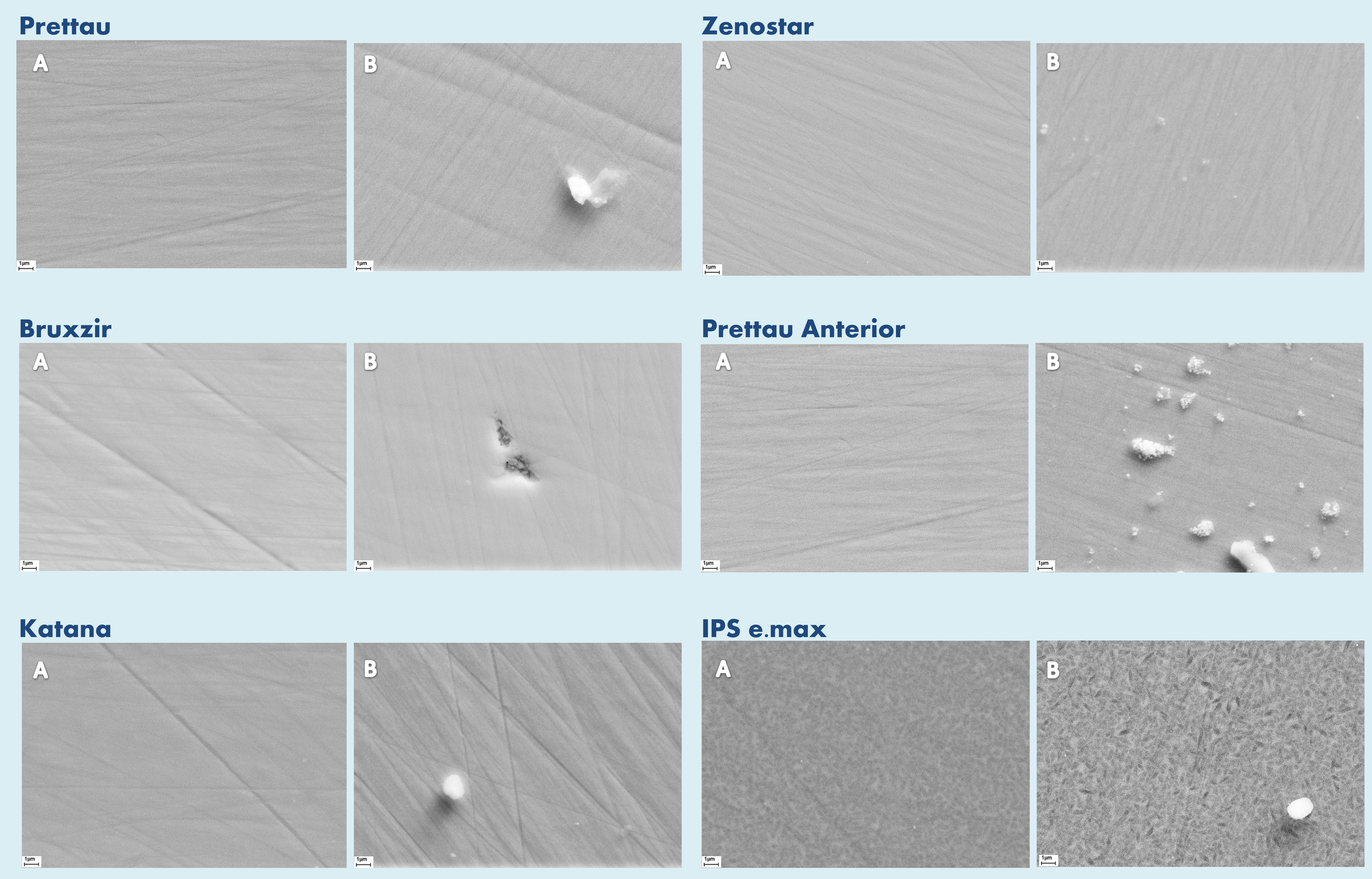
Monolithic Zirconia

Elements	PRT (atom %)		BRX (atom %)		ZEN (atom %)		KAT (atom %)		PRTA (atom %)	
	1	2	1	2	1	2	1	2	1	2
Zr	19.3	29.5	16.7	27.9	20.0	28.5	13.2	29.3	18.9	21.6
O	80.7	70.5	44.6	72.0	80.0	71.4	78.7	70.6	79.5	61.9
N	--	--	38.6	--	--	--	--	--	--	16.3
Al	--	--	--	--	--	--	0.2	--	1.2	--
Ca	--	--	--	--	--	--	7.9	--	--	--
Fe	--	--	--	--	--	--	--	--	0.5	--

IPS e.max CAD

	(Atom %)						
	Si	O	Mg	Al	P	K	Ca
1	26.1	73.7	--	1.5	1.2	1.0	0.4
2	22.4	69.6	0.1	1.3	1.1	1.3	--

Scanning electron micrographs (5000x) of the investigated specimens. (A) Before acid immersion (B) After acid immersion.



Conclusions

There is a definite ion interaction between the ceramic surface and an acidic aqueous environment.

Monolithic zirconia materials show smoother surfaces after an acidic challenge.

References

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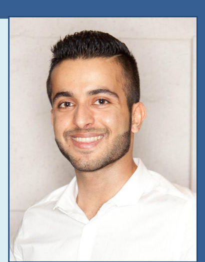

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