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In-vitro wear of natural tooth surface opposed with zirconia reinforced lithium silicate glass ceramic after accelerated ageing

Salma M. Fathy[a,*], *Michael V. Swain*[b]

[a] *Department of Dental Biomaterials, Faculty of Dentistry, Mansoura University, Mansoura, Egypt*
[b] *Discipline of Biomaterials, Faculty of Dentistry, University of Sydney, Australia*

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ABSTRACT

Objective. To evaluate the effect of different *pH* media on zirconia-reinforced lithium silicate glass ceramic and how they interact with opposing dentition after being aged in different *pH* cycling and high temperature conditions.
Methods. Twenty-five rectangular shaped specimens were prepared from lithium silicate reinforced with zirconia blanks (Suprinity, Vita Zahnfabrick) and stored in different *pH* media (3 & 7.2) for different periods (24 h & 7 days) at temperature (55 °C). After their surface roughness (Ra) evaluation, aged ceramic specimens were subjected to cyclic abrasive wear with opposing natural teeth enamel for 150,000 cycles using a chewing simulator. Weight loss and Scanning Electron Microscope (SEM) images were used to evaluate the cyclic wear results.
Results. After different *pH* storage, ceramic group stored at 3 *pH* for 1-W (1 week) gave significantly higher mean Ra value (0.618 μm ± 0.117) than control lowest mean value (0.357 μm ± 0.054) before cyclic wear. On the other hand, it caused the least significant weight loss value (0.004 gm ± 0.001) to opposing tooth enamel. There was significant tooth enamel weight loss (0.043 gm ± 0.004) when opposed with ceramic group stored in 3 *pH* media for 24 h (24-H). Their SEM images showed a prominent wear scar on enamel cusp tip. There was a significant increase in surface roughness Ra of ceramic material after abrasive cyclic wear.
Significance. Great attention should be paid to Ra of this type of glass ceramic even if it is considered as minimal values. It can induce a significant amount of enamel tooth wear after a period equivalent to one year of intra-oral function rather than the significantly higher surface Ra of such ceramic type can do.

1. Introduction

Dental ceramics are generally considered chemically inert restorative materials. However, many factors may influence the durability of dental ceramics. Different ceramic compositions and microstructures are exposed to different environmental factors such as the presence of erosive or acidic agents. The latter are caused by ingestion of certain fruits or beverages, inhalation of industrial acidic fumes or gastric juice regurgitated into the oral cavity as in the case of bulimia and anorexia nervosa. The exposure time to

* *Corresponding author.*
E-mail addresses: Salmafathy_dent@edu.eg (S.M. Fathy), michael.swain@sydney.edu.au (M.V. Swain).
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conditions similar to those prevailing in the oral cavity such low *pH*, elevated temperature and moisture may all affect the durability and enhance degradation of dental ceramics. There are other agents that may affect surface roughness and degradation of dental restorations and natural dentition as well. They are chewing of different foodstuff, brushing using abrasive toothpastes, inhalation of dust with fine abrasive particles, saliva composition, temperature, sex, age, nutritional and parafunctional habits, occlusion, neuromuscular forces, enamel thickness and hardness [1–7].

The exposure to acidic conditions results in selective releasing of alkaline ions, which are usually less stable in the glassy phase than in the crystalline phases of dental ceramics. The consequences of ceramic degradation are the enhanced roughness or coarseness of the exposed surface, resulting in an increase in plaque accumulation and wear to antagonist materials or teeth. Surface roughness increases the mechanical frictional loading which, in turn, enhances the appearance of in-service flaws on dental ceramics. Another type of flaw that ceramics may suffer from and aggravate their in-service survival is the presence of *processing* and *intrinsic* flaws [8,9]. The behavior of all-ceramic restorations and their interaction with opposing enamel or other non-ceramic restorative materials subjected to these challenges can be evaluated using two and three body wear testing under simulating load and environmental conditions. Although it is impossible to simulate clinical wear using in vitro studies because of the presence of multifactorial oral environmental conditions, but in-vitro results enable behavior of materials to be predicted and to evaluate the effect of specific variables independently [6,10].

Several studies [11–13] have evaluated the behavior and interaction of different ceramic types within the oral environment. Various ceramic related factors were reported to affect ceramic behavior, for example; the grain size and shape, the presence of glassy and/or crystalline phases, the type of reinforcing crystalline phase like leucite or fluoroapatite or other crystal type and finally ceramic composition especially the presence of some elements or oxides that affect corrosion resistance of ceramics and, in turn, its surface roughness and wear rates.

The newly introduced version of lithium disilicate glass ceramic containing zirconia (≈10% by weight) (Vita Suprinity; Vita Zahnfabrick, Bad Säckingen, Germany) has proved to have higher strength than traditional lithium disilicate ceramics. It is used as monolithic restoration and indicated for dental CAD/CAM applications to fabricate inlays, onlays, partial crowns, veneers and anterior & posterior crowns [14]. Due to the claim of being stronger than existing lithium disilicate glass ceramics after crystallization, this material can be used in the posterior region of the mouth [14,15]. This situation makes it subjected to even higher occlusal loads than previous generations of glass ceramics, which along with its composite (glassy and crystalline phases) composition and different erosive agents in the mouth warrants critical appraisal. All these factors may together aggravate its surface roughness and wear beside the interaction with the opposing natural dentition. So that the aim of this study is to evaluate the effect of different *pH* media on zirconia-reinforced lithium silicate glass ceramic and how they interact with opposing dentition after being aged in different *pH* cycling and high temperature conditions.

2. Materials and methods

2.1. Materials

The material used in the present study are shown in Table 1.

2.2. Methods

2.2.1. Specimens preparation

Twenty-five rectangular shaped specimens rectangular shaped specimens were cut from the lithium silicate reinforced with zirconia blanks (Vita Suprinity; Vita Zahnfabrick, Bad Säckingen, Germany) using a water-cooled low-speed diamond saw (Isomet, Buehler GmbH, Düsseldorf, Germany). The cut specimens were carefully polished with silicon carbide abrasive papers (400P and 800P) (Struers, Copenhagen, Denmark) under water-flow to remove any sharp points. Further specimens' crystallization was accomplished using VITA VACUMAT 6000 M furnace (Vita Zahnfabrick, Bad Säckingen, Germany) following the respective manufacturer's recommendations. After crystallization, final polishing of glass ceramic specimens was done with a decreasing sequence of abrasiveness for the silicon carbide abrasive papers (P400, P800, P1200, P2400, and P4000-grit) under copious amount of water-cooling and using polishing paste (Meta Di, 1 μm grain size, Dusselford, Germany) and a polishing machine (Struers, Copenhagen, Denmark) in order to obtain extra-smooth, mirror-like surface of polished specimens. After their preparation, ceramic specimens were stored in adequately closed polyethylene 20 ml clear jars (Thornton Plastics, Salt Lake, USA) and sealed carefully with by means of parafilm wrap (4 in. × 125 ft) roll (Bemis Company Inc., USA) to control moisture entrance till the time of immersion in different *pH* buffering media [11,16].

2.2.2. Natural dentition antagonist

Thirty sound upper human premolar teeth were collected from Mansoura University, Faculty of Dentistry external clinic's patients after taking their approval to use their teeth in the present study. Extracted teeth were examined using USP digital microscope (Scope Capture, Digital microscope, Guangdong, China) connected with an IBM compatible personal

Table 1 – Material used in this study.

Material	Composition	Manufacturer	Blanks Info.
Vita Suprinity.	Zirconia containing lithium silicate glass-ceramic (SiO_2, Li_2O, K_2O, P_2O_5, Al_2O_3, ZrO_2, CeO_2, pigments).	Vita Zahnfabrick, Bad Säckingen, Germany.	A2-HT PC-14. LOT62840.

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