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Original Research Article

Evaluation of Natural Enamel Wears Against Polished Yitrium Tetragonal Zirconia and Polished Lithium Disilicate: Comparative Study

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Abstract

Aim: To compare wear of the natural teeth against polished yttrium tetragonal zirconia and polished lithium disilicate crowns.

Material & Methods: This study was carried out in the Department of Maxillofacial Surgery, Narayan Medical College & Hospital, Sasaram, Bihar, India, over a period of one year. A total of 20 patients were included in the study.

Results: Wear was measured using baseline and 12-month interval cast of opposing dentition and 3D scanning and superimposition technique. A statistically significant difference was found in the comparison of the amount of natural enamel wear against polished zirconia crowns (Group 1) with the amount of natural enamel wear against natural antagonist (control Group 1, i.e., 35.72 µm) (P = 0.01).

Conclusion: Within the limitations of the study, it can be concluded that polished lithium disilicate showed better clinical outcome than polished yttrium tetragonal zirconia, though the evaluated data was statistically non-significant.

Keywords: Polished lithium disilicate, polished yttrium tetragonal zirconia, wear

Introduction

Zirconia became popular in dentistry because of this material's excellent mechanical properties [1], which include high strength, fracture toughness [2–4], and biocompatibility [5, 6]. Zirconia was mainly used as a substructure for ceramic-ceramic restorations and required veneering ceramics to obtain proper esthetics because of their high opacity. In general, these ceramic-ceramic restorations exhibited superior esthetic properties compared with their metal-ceramic counterparts [7–9]. Despite the excellent physical properties of zirconia, veneer chipping has been identified as a major cause of failure. A systematic analysis of zirconia-based FDPs shows a survival rate of 94.3% [10]. However, when technical complications such as chipping of the veneer ceramic are included, their survival decreases to 76.4% [10].

Several recent clinical studies have examined natural enamel wear opposing high strength ceramics. A study by Esquival-Upshaw et al. concluded that lithium disilicate, either polished or glazed following adjustment, caused less wear to opposing teeth than veneering porcelain after 3 years. [11] Quantitative measurement of wear in that study revealed no difference between teeth opposing natural teeth or lithium disilicate crowns. [12] A 2 year study by Etman et al., however, showed less wear on enamel opposing veneering porcelain (106 mm/1 yr and 156 mm/2 yr) than adjusted and polished lithium disilicate (149 mm/1 yr and 214 mm/2 yr). [13]

However, attempts to correlate the in-vitro results with the long-term, in vivo situation have not been very successful. Complex in vivo wear behavior cannot be predicted from physical and mechanical testing. [14-15] In-vitro studies do not represent the actual masticatory environment and cannot simulate the intricate chewing pattern. Hence, there was a need for an in vivo study evaluating the wear potential of monolithic yttrium-tetragonal zirconia polycrystals (Y-TZP) and monolithic lithium disilicate crowns and comparing it with the wear occurring in natural dentition.

Thus, we aim to compare wear of the natural teeth against polished yttrium tetragonal zirconia and polished lithium.

Material & Methods:

This study was carried out in the Department of Maxillofacial Surgery, Narayan Medical College &Hospital, Sasaram, Bihar, India, over a period of one year. Ethics was granted by the Institutional Ethical Committee and research board approval. Informed consent was signed by the patient in their regional languages, and the study conducted according to the ethical standards given in the 1964 Declaration of Helsinki, as revised in 2013. A total of 20 patients were included in the study.

The sample was divided into two groups, namely Groups A and B. Each group was assigned 10 participants each. The study was randomized clinical trial, and the samples were selected using these inclusion and exclusion criteria.

1. The inclusion criteria for the participants were as follows:

- Normal occlusion
- Presence of natural antagonist against the proposed full-coverage crown Participants needed a crown on either first molar or second molar of any arch
- Presence of natural antagonist on the contralateral side for comparative analysis
- The age group of 20–40 years.

2. The exclusion criteria for the participants were as follows:

- Medical contraindication for dental treatment
- Participants with parafunctional habits, for example, bruxism
- Participants with temporomandibular joint disorder and habit of unilateral mastication
- Uncertain residency in the area within the 1-year
- Duration of the study.

From the selected thirty participants, 15 participants were divided into Group A to receive polished yttrium tetragonal zirconia full-coverage crowns, and 15 participants were divided into Group B to receive polished lithium disilicate full-coverage crowns. The tooth preparation for individual participants was done following the standard protocol. Polished monolithic yttrium tetragonal zirconia (Sagemax white zirconia blocks) and polished lithium disilicate (Ingots-IPS e. max, Ivoclar Vivadent, Germany) full-coverage crowns were fabricated according to the manufacturer's instructions. Each full-coverage crown was cemented using Type I glass-ionomer luting cement (GC Gold Label, Japan).

The baseline data were collected by recording the impression of the arch opposing the full-coverage crown at the time of cementation with medium-bodied consistency polyvinyl-siloxane impression (medium body, Reprosil, Dentsply, USA) material in the photo polymerized tray (Voco Profibase, Germany). A 3D white light scanner [Zirkon Zann Sagoo Arti, Germany; Figure 1] with accuracy up to 14 µm was used to scan the baseline casts. The participants were recalled for the evaluation of the full-coverage crowns after 12 months. At the end of 12 months, the final data were then collected by recording a second impression of the arch opposing the cemented full-coverage crown with medium-bodied consistency polyvinyl-siloxane impression material. This final impression was disinfected, poured, and the cast was scanned in a similar manner as the baseline casts.

After scanning, the scanner was allowed for 3D superimposition of the baseline and final scanned images of individual participants by the selection of three reference points or areas that are not subjected to wear. It then locates and quantifies the spatial differences between the two images, thereby measuring the amount of wear in three dimensions, giving a more realistic view of the clinical characteristics of wear and the potential mechanisms involved. Data collected by experiments were computerized and statistically analyzed. The normality of the data was checked using the Kolmogorov–Smirnov test and Shapiro–Wilk tests. Lawson et al., in their study, used a similar test for normality evaluation. [16] The data were normally distributed. Statistical analysis was performed by using the tools of descriptive statistics such as mean and standard deviation for representing quantitative data (enamel wear measured in µm) parametric tests: Student's t-test for intergroup comparison was done as the sample size was not more than 20.

Results:

Wear was measured using baseline and 12-month interval cast of opposing dentition and 3D scanning and superimposition technique. The enamel wear recorded in the participants of Group 1 and Group 2 at the end of 12 months interval is tabulated in Table 1 and for Group 2 in Table 2, respectively.

Table 1: Comparison of amount of natural enamel wear against polished yttrium tetragonal zirconia Crowns (Group 1) with enamel wear against natural antagonist (Control Group)

Case number	Group 1 – Polished yttrium–tetragonal polycrystals crowns			Control group	
	Tooth number with crowns	Antagonist tooth number	Enamel wear (µm) against crowns	Natural Teeth considered	Mean enamel wear (µm) of natural antagonist
1	14	12	50.2	16.4	30.6
2	42	44	34.7	22.9	27.8
3	42	40	46.9	20.4	33.9
4	12	14	30.4	15.4	31.0
5	12	42	47.0	20.7	27.9
6	30	42	37.7	13.8	26.6
7	32	12	32.8	12.3	36.8
8	12	14	30.4	10.5	43.8
9	44	42	27.6	15.2	40.1
10	40	42	22.8	18.9	33.8

Table 2: Comparison of amount of natural enamel wear against polished lithium disilicate Crowns (Group 2) with enamel wear against natural antagonist (Control Group)

Case number	Group 2 – Polished lithium disilicate crowns			Control group	
	Tooth number with crowns	Antagonist tooth number	Enamel wear (µm) against crowns	Natural Teeth considered	Mean enamel wear (µm) of natural antagonist
1	30	42	37.7	13.8	26.6
2	32	12	32.8	12.3	36.8
3	12	14	30.4	10.5	43.8
4	44	42	27.6	15.2	40.1
5	40	42	22.8	18.9	33.8
6	14	12	50.2	16.4	30.6
7	42	44	34.7	22.9	27.8
8	42	40	46.9	20.4	33.9
9	12	14	30.4	15.4	31.0
10	12	42	47.0	20.7	27.9

A statistically significant difference was found in the comparison of the amount of natural enamel wear against polished zirconia crowns (Group 1) with the amount of natural enamel wear against natural antagonist (control Group 1, i.e., 35.72 µm) (P = 0.01) [Table 3].

Table 3: Comparison of amount of natural enamel wear against polished yttrium–tetragonal zirconia polycrystals crowns (Group 1) with enamel wear against natural antagonist (Control group)

Groups	Mean (µm)	SD	SE	Student t-test	P, significance
Enamel wear against Polished Y-TZP crowns (group 1)	44.7	6.82	1.63	4.282	0.001
Enamel wear against natural antagonist (control group)	34.2	6.43	1.42		

A statistically significant difference was found in the comparison of the amount of natural enamel wear against polished lithium disilicate crowns (Group 2) with the amount of natural enamel wear against natural antagonist (control Group 2, i.e., 34.62 µm) (P = 0.001) [Table 4].

Table 4: Comparison of amount of natural enamel wear against polished lithium disilicate crowns (Group 2) with enamel wear against natural antagonist (control group)

Groups	Mean (µm)	SD	SE	Student t-test	P, significance
Enamel wear against polished lithium disilicate crowns (group 2)	40.2	6.32	1.52	0.821	0.001
Enamel wear against natural antagonist (control group)	31.7	6.02	1.28		

On the comparison of polished zirconia crowns (Group 1, i.e., 42.72 µm) with the amount of natural enamel wear against polished lithium disilicate crowns (Group 2, i.e., 42.02 µm), no statistically significant difference was found among both experimental groups (P = 0.542). It is suggested that enamel wear occurring against both experimental groups was comparable [Table 5].

Table 5: Comparison of amount of natural enamel wear against polished Yttrium–tetragonal zirconia polycrystals crowns (Group 1) with amount of natural enamel wear against polished lithium disilicate crowns (Group 2)

Groups	Mean (µm)	SD	SE	Student t-test	P, significance
Enamel wear against Polished Y-TZP crowns (group 1)	44.7	6.82	1.63	4.282	0.001
Enamel wear against polished lithium disilicate crowns (group 2)	40.2	6.32	1.52	0.821	0.001

Discussion:

A study by al-Hiyasat et al. [17] suggested that it is necessary to glaze or polish porcelain following adjustment to reduce opposing enamel wear. In their study, porcelain which was adjusted with a fine diamond bur produced more enamel wear than glazed or polished specimens. The mechanism of wear of veneering porcelain, however, is different than that of high strength ceramics like lithium disilicate and zirconia. Veneering porcelain fractures during wear and creates sharp asperities on its surface which abrade opposing enamel. Additionally, the fractured fragments of porcelain may act as third-body particles, further potentiating the wear process. [18]

No surface wear was visible on polished or adjusted zirconia but measurable wear occurred on the surface of lithium disilicate. [19-20] Lithium disilicate has shown to produce more volumetric wear loss than zirconia when opposed by zirconia. Some of these previous studies showed that lithium disilicate caused more wear to opposing enamel than zirconia,[19-21] while another study found that lithium disilicate causes less enamel wear than zirconia. [22] More enamel wear opposing lithium disilicate would have been expected since this material experiences more surface wear and should have a resultantly rougher surface.

A comparison of enamel wear against zirconia among the 1-year studies shows Munde at 84.5 µm, Cardelli [23] at 76 µm and the current study at 70.3 µm. These values are all comparable with each other. However, compared with Munde's enamel-enamel control (26.2 µm) for the same patients, the enamel wear against zirconia is higher. There was no enamel-enamel control for Cardelli's study. For this current study the enamel control was 61.6 µm which is comparable to the enamel- zirconia wear. For the studies reporting 2-year wear, the antagonist enamel wear reported for Lohbauer [24] was 204 µm and Stober was 151 µm. While these values by themselves seem comparable, Lohbauer's conclusion that zirconia is enamel friendly is hard to validate because the study is missing enamel-enamel controls. In Stober's study, they state that the wear of enamel vs. zirconia is greater than that compared with enamel vs. enamel (95 µm) for the same patient.

The study shows no statistical difference between polished zirconia and polished lithium disilicate crown. The probable reason for it could be a monolithic crown; it is in accordance with the studies by Rupawala et al., Palmer et al., and Lawson et al. [25-28]

Conclusion:

Within the limitations of the study, it can be concluded that polished lithium disilicate showed better clinical outcome than polished yttrium tetragonal zirconia, though the evaluated data was statistically non-significant.

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