Evaluation of antagonist Wear behavior and patient satisfaction of Monolithic Zirconia versus Lithium Silicate Zirconia crowns. (Randomized clinical study)

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ABSTRACT

\textbf{Aim:} The purpose of this study was to evaluate the degree of time dependent wear of antagonist natural enamel and patient satisfaction for zirconia reinforced lithium silicate when compared to monolithic zirconia crowns at 0,3,6,1 year follow up periods.

\textbf{Methodology:} A total of 26 posterior teeth (7 females and 4 males) were selected for this study with an age range of 20-60. Then they were divided into two groups (1&2) according to the masking method (N=13). First group received monolithic zirconia crowns over posterior teeth up to two crowns per patient. Second group received zirconia reinforced lithium silicate crowns over posterior teeth up to two crowns per patient.
Immediately after cementation of the restoration addition silicone impression were taken for the antagonist teeth and epoxy model were poured. Then assessment of the restoration for patient satisfaction and shade matching was done postoperatively. Wear of enamel antagonist of the two groups were assessed using 3D Profilometer measured in micrometer through the epoxy model made after the follow up visits 3-6-12 month followed by evaluation of the Patient satisfaction of the two groups which were assessed using VAS (visual analogue scale questionnaire that collect history of reactions) which is represented by a scale from 1-10.

**Results:** Repeated measures Analysis of Variance (ANOVA) was used to study the effect of ceramic type, time and their interactions on mean Ra. Bonferroni’s post-hoc test was used for pair-wise comparisons when ANOVA test is significant. For non-parametric data, Mann-Whitney U test was used to compare between the two ceramic types. Friedman’s test was used to study the changes by time within each ceramic type. Between mean age values there was no statistically significant difference in the two groups. Also, between gender distribution, no statistically significant difference was reported in the two groups. The results showed that ceramic type (regardless of time) had a statistically significant effect on mean Ra (P-value <0.001, Effect size = 0.721). Time (regardless of ceramic type) had no statistically significant effect on mean Ra (P-value = 0.828, Effect size = 0.018). Monolithic Zirconia showed statistically significantly lower mean Ra than ZLS (P-value <0.001, Effect size = 0.721). VAS scores data showed non-normal (non-parametric) distribution while age and Ra data showed normal (parametric) distribution. Data were presented as mean, standard deviation (SD), median and range values. For parametric data, Student’s t-test was used to compare between mean age values in the two groups.

**Conclusion:** The ceramic type (regardless of the time) has an effect on the surface roughness (RA) of the antagonist enamel while time (regardless of the ceramic type) had no effect on the antagonist surface roughness, polished monolithic zirconia is an enamel friendly restoration showing acceptable enamel wear behavior. Enamel wear doesn’t seem to increase by time with properly polished monolithic restorations. Monolithic
zirconia restorations showed less satisfaction with esthetics than Zirconia reinforced lithium silicate ceramic restorations.

**Keywords:** Monolithic zirconia, zirconia reinforced lithium silicate, wear, antagonist enamel, patient satisfaction.

**INTRODUCTION**

Zirconia and Zirconia reinforced restorations exhibit well balance between excellent mechanical properties and satisfactory optical properties allowing for the production of dental prosthesis in the anterior and posterior regions using computer aided design (CAD), computer aided manufacturer (CAM) technologies. \(^{(1,2)}\)

Monolithic zirconia (MZ) full contour has been so popular recently as a substitution to core-veneered restorations. Several in vitro studies have reported that MZ crowns possess high resistance to fracture even at a minimum thickness of 0.5 mm. In addition to overcoming the problem of chipping. Moreover, in many in vitro trials on monolithic zirconia crowns have shown superior mechanical characteristics against other commercially available ceramics. \(^{(3)}\)
Whereas zirconia reinforced glass-ceramic systems have been progressively indicated for monolithic rehabilitations because of their enhancements which are continuously progressing in terms of their mechanical properties associated with their outstanding inherent optical characteristics.

Wear processes are one of the most distinguished disintegration mechanisms through the chewing cycle tests because of lateral friction mechanisms and the continuous simultaneous impact presence. (4) Tooth structure wear is an unavoidable natural mechanism which happen when, tooth-restoration or tooth-tooth are in contact and slide over one another. Yet, it could be augmented by the replacement of restorations which exhibit different wear characteristics that are different from those of the natural tooth surface when slide over each other.

With the increased use of zirconia as a monolithic restorative material, a major concern has evolved which is the abrasive nature of the material when opposed by natural enamel due to the material surface roughness and hardness (5,6,7).

Various in vivo and in vitro studies were conducted to define and locate the wear of enamel when opposed by zirconia restorations. Several studies demonstrated the wear of zirconia opposed by different types of antagonists, especially enamel, have shown that zirconia as a restoration is comparable to different restorative materials concerning wear of antagonist natural enamel structure. (7,8,9,10) But such studies are difficult to compare with one another due to differences in type of material, surface finish of material and the type of wear method evaluation used.

Measurement of patient-satisfaction is an important element in assessing the effectiveness and the quality of dental and health care, including the evaluation of different treatment phases and final treatment outcome (11,12). Visual analogue scales (VAS) are one of the patient’s satisfaction-based questionnaire, they are scales related to psychometric responses used in questionnaires or surveys. VAS is a method that is used to measure characteristics the are subjective and are not able to be quantified in addition it is a perfect tool to count perceptions, as well as used in social science investigations and market research.
Therefore, we aimed in this study to evaluate the degree of time dependent wear of antagonist natural enamel and patient satisfaction for zirconia reinforced lithium silicate when compared to monolithic zirconia crowns at 0,3,6,1 year follow up periods.

MATERIALS AND METHODS

Ethical considerations and approval:

This randomized clinical trial was conducted in the Department of Fixed Prosthodontics in Faculty of Dentistry, Cairo University. The ethical approval for the study was obtained from the Ethics Committee of Scientific Research - Faculty of Dentistry – Cairo University (approval no: 181036). Participation in the study was voluntary and informed consent was obtained from all of them before starting the treatment regarding treatment sequence, publishing of their images and results.

Registration:

This trial was registered at the Clinical Trials.gov with the Unique Protocol ID: CEBD-CU-2018-10-01 on October 2, 2018.

Trial design:

This study is a randomized controlled clinical trial including parallel group, two-arm, non-superiority trial with 1:1 allocation ratio.

The PICOT for this study were:

Population; Patients with single crown posterior restoration with opposing natural tooth.

Intervention; Zirconia reinforced lithium silicate glass.
Comparator: Monolithic zirconia.

Outcome measures:

Primary outcome: Tooth structure loss of antagonist, (measured by optical profilometry)

Secondary outcome: Patient satisfaction, (evaluated by VAS)

Time: one-year clinical follow-up.

Sample size calculation:

26 crowns total sample size (13 in each group) were sufficient with power 80% and 5% significance level. The sample size was calculated by the G power program. Or (Sample size calculation was achieved using PS: Power and Sample Size Calculation Software Version 3.1.2 (Vanderbilt University, Nashville, Tennessee, USA.)

Patient selection:

Total of 26 posterior teeth indicated for full coverage single crowns in patients with age range between 20-60 years old were selected for this study. Their chief complaint was that they are unable to eat on the affected tooth. Each patient was well educated with the whole treatment plan before the start of the study. They were motivated to follow a strict and proper oral hygiene routine. An informed consent was signed by each patient before the start of the clinical procedures.

They were recruited during the time from January 2020 till July 2020 from the outpatient clinic of Fixed Prosthodontics Department, Faculty of Dentistry, Cairo University, Cairo, Egypt. Screenings of patients were carried out until target number was reached. This study was completed by August 2021. Full medical and dental history was obtained from all participants.

Eligibility criteria:
a) **Inclusion criteria:**

1. Patients with normal occlusion and occlusal patterns

2. Patients who can read and write in order to sign the informed consent document with an age range from 20-60 to be and

3. Patients psychologically and physically able to tolerate conventional restorative process.

4. Patients present no pulpal diseases or any periodontal diseases, teeth with good restorations.

5. Patients received endo treatment and indicated for full coverage restorations on either a premolar or first and second molar in either arch.

6. Patients indicated for full coverage as the in the following situations: coronal fracture, moderate to severe discoloration and malformed teeth or malposed) on either a premolar or first and second molar in either arch.

7. Patients able to return for follow-up assessments and examinations.

8. Participants with antagonist natural sound enamel.

9. Up to 2 crowns per patient maximum without having direct contact occlusally with each other.

10. The antagonist arch not having a full coverage restoration nor a partial denture.

11. Crown: root ratio of the tooth to be restored is at least 1:1.

b) **Exclusion criteria:**

1- Patients with fair oral hygiene and with no motivation since adding a restoration will end up in periodontal problems”.

2- Patients with no antagonist in the area supposed to receive restoration “as the effect of the protheses on antagonist tooth will be measured”.
3- Patients with any restoration antagonizing the crown to be restored.

4- Young patients during the growth stage having teeth partially erupted.

**Sequence generation**

The participants were allocated into two groups with 1:1 allocation ratio by using computerized Sequence generation (www.randomizer.org).

**Allocation concealments mechanism:**

Each participant was given a number in every group that was written on a large white paper sheet. Then folded eight times and stored inside well sealed opaque envelope so that the inside cannot be visible.

**Implementation:**

(E.R) and (K.H) were in charge for providing allocation generation and splitting patients into 2 groups and stored in the envelopes in secured place until the start date of the clinical procedures.

**Randomization:**

By using computerized Sequence generation (www.randomizer.org) randomization was carried out in the Center of Evidence Based Dentistry, Cairo University. Participants were assigned in two groups (1 or 2) according to the material type of the restoration received. Each participant received a sealed opaque envelope with their randomized number. The 26 posterior teeth were split into 2 groups (13 patients each) depending on the material of the crowns used, as follows:

**Group (1): Comparator group:** Teeth receiving full coverage polished monolithic zirconia crowns in the posterior area.

**Group (2): Intervention group:** Teeth receiving full coverage polished zirconia reinforced lithium silicate crowns in the posterior area.
**Masking/Blinding:**

Every participant selected in this study was blinded (not knowing intervention type received). Double blind (trial participants and outcome assessors) while the operator (the researcher) will not due to the difference in restorative material presentation and application protocol.

**Clinical Procedures:**

**I. Diagnostic phase:**

A total of 26 posterior teeth (7 females and 4 males) were included in this study. All patients received the same clinical protocols by the same experienced operators. After patient' history (medical, dental) followed by dental examination was done including assessment of remaining tooth structure, occlusal scheme, periodontal condition, oral hygiene, dental caries and parafunctional habits.

Radiographic examination to assess the quality of the endodontic treatment, alveolar bone level and crown/root ratio. Scaling and polishing were performed for each patient before start of tooth preparation to remove any dental plaque and calculus which will affect the results and shade selection. After cleaning the tooth surface, shade selection for the teeth to be restored with Zirconia Lithium silicate crowns was done using Vita 3D Master shade guide while that to be restored with monolithic zirconia crowns shade selection was done with VITA Classical Shade Guide. Canon 6D full frame macro lens canon 100L was used to capture pre-operative photographs for every patient. Diagnostic casts fabricated from alginate impressions (CA 37,Cavex, Haarlem, The Netherlands) were mounted on a semi adjustable articulator using jaw relation records obtained from each patient.
II. Teeth Restoration:

Most teeth were restored by just composite core as those teeth were minimally destructed after receiving root canal therapy. Other teeth were restored with post and composite core due to severe destruction.

- After teeth build up either with post and core or only composite core direct fabricated putty silicon index were recorded for temporary restoration fabrication.

- Teeth receiving ZLS restorations, 1 mm of axial tooth reduction, 1.5-2 mm of occlusal reduction were done with deep chamfer finish line via round tapered diamond stone (850-314-016, Komet, Germany).

- While for the teeth receiving monolithic zirconia restorations, 1 mm of axial tooth reduction, 1-1.5 mm of occlusal reduction were done with deep chamfer finish line using round tapered diamond stone (850-314-016, Komet, Germany).

- Retraction cord was applied to place the finish line sub-gingivally in some case to increase the preparation height.

- An index was cut Bucco-lingually to check and confirm the amount of preparation for every tooth.

- Preparations were finished using finishing stones (856EF-314-016, Komet, Germany) and soflex disc kit.

- All reduction procedures were done by the same operator (researcher).

Prior to recording of the final impression retraction cord was applied. Then single step impression technique was made with soft putty and light viscosity (Elite HD, Zhermack, Italy). The direct fabricated silicon index was used for temporary restoration fabrication.

Laboratory procedures:

After receiving the final impressions, the dental laboratory started pouring the master casts using type IV dental stone (Fuji-Rock-EP, GC-Belgium) following the manufacturer’s instruction, in terms of powder: water ratio and exact time of mixing. To ensure proper accurate mixing that will produce voids free cast, mixing was done under
vacuum. Dowel pins were placed then the dies were sawed to allow for appropriate restoration designs with accurate margins placement. The master casts were scanned using five axes extra oral scanner (DOF “Degree of freedom”, South Korea) and then 3D images were taken for the prepared teeth, which were displayed on a computer screen. Using EXOCAD software ((EXOCAD Dental CAD, EXOCAD, Germany) a virtual model was calculated from the scanned images and an automatic margin finder was used for preparation margin detection. 80 microns was set by the software for the cement space. Then the crowns were designed and checked by the researcher to confirm the final design. After the final designs were confirmed by the researcher, PMMA crowns (White peaks PMMA, Germany) were milled and tried on the corresponding teeth and any occlusal adjustments were made in this try-in phase if needed. The crowns were milled from the Vita Suprinity blocks and super translucent Katana blanks using 5-axis milling machine (imes-icore CORiTEC 350i, Germany). After the milling process prior to sintering and crystallization, the restorations were cleaned thoroughly with steam jet. Sintering of the monolithic zirconia crowns was performed in a ceramic furnace (TS-2/M/ZIRKON-120, Germany) while the crystallization firing protocol of the Zirconia reinforced silicate crowns were made in accordance with the manufacturer’s indications in (Programat EP 310, Ivoclar Vivadent, Schaan, Liechtenste). The crowns were tried and checked on their corresponding dies for seating after sintering. All monolithic zirconia restorations were polished via polishing kit recommended by the manufacturer. (katana zirconia twist dia, Kuraray Noritak) and polishing Paste (Pearl Surface Z,Kuraray Noritake) while Polishing of ZLS “Vita Suprinity” crowns after crystallization, were manually done via VITA SUPRINITY instruments of the technical Polishing Sets (Vita Suprinity Technical Polishing Set, Vita Zahnfabrik, Bad Säckingen,Germany).

**Cementation of the final restorations:**

Prior to final adhesion, the produced restorations were tried in over the corresponding teeth where restoration margins were checked clinically then floss was used to check the interproximal contacts. Intraoral radiographs were taken to check and confirm
the margins radiographically. After try-in of the monolithic crowns, they were cleaned with cleaning paste (Ivoclean, Ivoclar Vivadent AG, Germany) then rinsed with water. Then a thin layer of zirconia primer (Z-Prime Plus, BISCO, USA) was applied on the fitting surface of the monolithic Zirconia crowns and air dried for 3 to 5 seconds. While after try-in of ZLS crowns, they were treated using Hydrofluoric acid (Ultra Dent porcelain etch, USA) surface conditioning with 9% hydrofluoric acid for 20 seconds then silane coupling agent (Ultra Dent silane, USA) was applied which were left to evaporate for 60 seconds. After rubber-dam isolation, prophylaxis paste, and polishing brush mounted in low-speed contra angle were used to clean all teeth surface prior to bonding. Teeth surfaces were dried gently for 5 seconds then self-adhesive luting resin cement (Biscem self-adhesive, Bisco, USA) was applied to the fitting surfaces of the crown using an auto mixing tip. The crown was placed to the tooth in position till complete seating using finger pressure. Excess cement was removed using sharp explorer after 2 seconds of preliminary light polymerization and the crown was then completely light polymerized with an energy density of 480 mW/cm for at least 20 seconds from each aspect of the tooth. A waxed dental floss was used inter-dentally for complete removal of excess cement in between crown and adjacent teeth. All patients were instructed to perform brushing and flossing regularly, using non-abrasive fluoridated toothpaste.

**Clinical evaluation:**

Restoration’s evaluation was assessed by three independent assessors for primary and secondary outcomes at baseline, 3, 6 and 12 months.

Regarding the wear evaluation (primary outcome), Sectional impressions was recorded for the antagonist arch as a base line index with vinylpolysiloxane addition silicon in sectional stock trays directly after crowns have been cemented to its corresponding teeth. Then replicas were fabricated by pouring these indices with epoxy resin immediately after the indices were taken from the patients. Same procedure will be repeated during the follow up period at 3,6 and 12 months. (**Figure 1,2**)
The optical method was used for wear evaluation where epoxy resin casts were photographed using USB Digital microscope with a built-in camera connected with an IBM compatible personal computer using a fixed magnification of 120 with a resolution of 1280 × 1024 pixels per image. Digital microscope images were cropped to 350 x 400 pixels using Microsoft office picture manager to standardize area of measurement. The cropped images were analyzed using WSxM software. In this software, all limits, sizes, frames and measured parameters are expressed in pixels. Therefore, system calibration was done to convert the pixels into absolute real-world units. Calibration was made by comparing an object of known size (a ruler in this study) with a scale generated by the software Subsequently, a 3D image of the surface profile of the tooth was created. Five 3D images were collected for each tooth in the central area and in the sides at area of 10 μm~10 μm. These period images were superimposed against one another using
tripodization by identifying three points on the occlusal anatomy which are expected to remain stable (i.e., marginal ridges) The cropped images were analyzed using WSxM software to calculate average of heights expressed in μm “Wear measurements”. After proper matching was achieved between different periods of follow up, the maximum wear of teeth at these time periods were compared and recorded. After that, topographic changes were determined by optical profilometer.

**Statistical Analysis**

Wear (Ra (surface roughness)) data were expressed as the mean and standard deviation. After homogeneity of variance and normal distribution of errors had been confirmed, Repeated measure ANOVA was performed to compare between different groups and follow-up periods followed by multiple comparisons with Bonferroni correction. (α =0.05) (IBM SPSS, version 23, Armonk, USA).

Regarding evaluation of patient satisfaction (secondary outcome), In order to estimate patient satisfaction with the restorations throughout the follow up period (3,6,12) a 10-cm visual analog scale (VAS) (range, 1 to 10) was used (Fig 3). All patients had the chance to quantify subjective parameters by using this scale, which would be difficult to analyze and standarize statistically by other ways. This questionnaire was easy to read, understand and complete by all patients. In addition, it has been validated and utilized in several studies of prosthodontic treatment.

For assessing the general satisfaction of the patients with the restorations the VAS questionnaire was used in terms of; ability to speak, comfort and stability, self-esteem, ease of cleaning, esthetics, and function. The anchor words were “completely satisfied” and “totally dissatisfied” (13)
RESULTS:

1- Wear Evaluation:

Repeated measures ANOVA revealed that ceramic type (regardless of time) had a statistically significant effect on mean Ra (\(P\)-value < 0.001, Effect size = 0.721). Time (regardless of ceramic type) had no statistically significant effect on mean Ra (\(P\)-value = 0.828, Effect size = 0.018). Furthermore, the interaction between the two variables had no statistically significant effect on mean Ra (\(P\)-value = 0.640, Effect size = 0.034). Additionally Monolithic Zirconia showed statistically significantly lower mean Ra than ZLS (\(P\)-value < 0.001, Effect size = 0.721).
The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between Ra (μm) of the two ceramic types regardless of time is shown in Table (1), Figure (4,5)

<table>
<thead>
<tr>
<th>Monolithic Zirconia</th>
<th>ZLS</th>
<th>P-value</th>
<th>Effect size (Partial eta squared)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>0.2530</td>
<td>0.0031</td>
<td>0.2666</td>
<td>0.0168</td>
</tr>
</tbody>
</table>

*: Significant at $P \leq 0.05$

**Figure (4):** Bar chart representing mean and standard deviation values for Ra of the two ceramic types
Figure (5) Bar chart representing mean and standard deviation values for Ra at different times of measurement

2- Patient satisfaction:

A&B. General Satisfaction and Comfort:

In the two groups no statistically significant difference was found between median satisfaction scores at base line, 3, 6 and 12 months.

While for the changes noticed among Monolithic Zirconia; a statistically significant change was found in satisfaction scores with time ($P$-value = 0.029, Effect size = 0.241).

figure (6,7)

C. Satisfaction with esthetics:

During base line recordings, 3, 6 and also at 12 months; Monolithic Zirconia group reported statistically significantly lower median satisfaction with esthetics values compared to ZLS group ($P$-value = 0.050, Effect size = 0.764) for each time, respectively.
While for changes noticed by time within each group; no statistical comparison could be done because scores didn’t change in each group at all observation periods. Figure (8)

D. Satisfaction with ease of cleaning

No statistically significant difference was reported between median satisfaction scores in the 2 groups at base line, 3, 6 and also at 12 months. In regard to changes with time within ZLS group; a statistically significant change was reported in satisfaction scores with time (P-value = 0.029, Effect size = 0.241). Figure (9)

E. Satisfaction with ability to speak, self-esteem, functionality:

All patients in the two groups recorded score (10) so no statistical comparisons could be done.

Figures (6,7): Box plot representing median and range values for general satisfaction and comfort scores in the two groups

Figure (6)  Figure (7)

Figure (8,9): Box plot representing median and range values for satisfaction with esthetics scores in the two Groups

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3 - Surface topographic changes:

Topographic changes for enamel surface opposing to monolithic zirconia and ZLS were evaluated, and different topographic changes were determined by optical profilometer throughout all the follow up periods at baseline (immediately after cementation), 3, 6 and 12 months. Figures (10-15)

Figure (10): Surface topographic changes for enamel surface opposing monolithic zirconia crown “6 and 12 months respectively”.

Figure (11) - Surface topographic changes for enamel surface opposing Monolithic zirconia crown “Baseline and 3 months respectively”.

respectively”.

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Figure (12,13): surface topographic changes for enamel surfaces opposing ZLS crown “Baseline and 3 months respectively”.

Figure (14,15): surface topographic changes for enamel surfaces opposing ZLS crown “6 and 12 months respectively”.
DISCUSSION

Ceramics have a high degree of intra-oral stability owing to its biocompatibility and being an inert material. Hence, they can safely be used inside of the oral cavity. They recently play an important role in all fields of dentistry especially in cosmetic dentistry. Modern dentistry has led to the birth of many ceramic materials and construction techniques. However, they are brittle being easily fractured. To compensate for this weakness, particles were added to ceramics for reinforcement or ceramics were made completely of polycrystalline material. \(^{14,15}\)

The aim of the research and development of new different restorative materials is getting high mechanical and esthetic performances which led to the introduction of zirconia-reinforced lithium silicate ceramics (ZLS) in the market, that can be manufactured and produced with Computer-aided design / Computer-aided manufacturing (CAD/CAM) technologies. In addition to improvements in monolithic zirconia restorations which recently added the benefit of esthetics to the excellent mechanical properties.

In spite the superior mechanical characteristics of the zirconia and zirconia-based restorations, the insufficient translucency and white opaque color that demand porcelain coating with a glassy layer of ceramic over the framework to enhance esthetics and achieve natural appearance which is known as veneered zirconia. Yet, chipping and fracture of the ceramic coating over the zirconium core during clinical service was reported in long-term clinical observations \(^{16}\).

Owing to the decrease in the compressive strength (100–150 MPa) of the ceramic coat; in addition to, the difference in the linear expansion coefficient between the framework and the veneering material, resulting in decrease bonding strength, chipping or cracking of the porcelain coat has been reported to be the main complication of such restorations. \(^{17}\) There are many ways to solve and overcome the problem of chipping as it is multifactorial. One of them is introduction of yttria stabilized tetragonal zirconia polycrystal (Y-TZP) for different monolithic restorations. Two different types of monolithic zirconia materials are available: translucent and opaque zirconia. Opaque
zirconia exhibit significantly higher flexural strength (900-1200 Mpa) due to the presence of tetragonal grains while the more translucent zirconia has greater natural esthetic characteristics due to the cubic grain which is 100%, stabilized with 5.5% mol and 5.0% mol yttria with flexure strength reduced to reach the range between (500-800 Mpa) \(^{(18,19)}\). With the increased use of zirconia as a monolithic restorative material, a major concern has evolved which is the abrasive nature of the material when opposed by natural enamel due to the material surface roughness and hardness \(^{(5,20,21)}\). Material overall hardness and surface roughness were frequently reported in literature as major causative factors for opposing tooth surface wear which became a major concern when monolithic zirconia was introduced due to its proven surface hardness. Recent in vitro studies when tested antagonist tooth surface wear against monolithic zirconia in comparison to other ceramic and restorative materials have reported a similar antagonist wear rate as well as an excellent ability of monolithic zirconia restorations to maintain its polished surface after many years of clinical service. Evidence-based dentistry is the exercise to apply the best available scientific results to guide clinical management \(^{(22)}\). Patient-evaluated dentistry can be defined as the training of applying subjective information described by the patients to guide this management. Therefore, we aimed in this study to evaluate the degree of time dependent wear of antagonist natural enamel and patient satisfaction for zirconia reinforced lithium silicate when compared to monolithic zirconia crowns at 0, 3, 6, 1 year follow up periods. Our present study was a randomized double blinded clinical trial where randomization was carried out by using computerized sequence generation (www.randomizer.org) for random allocation of patients to eliminate the risk of selection bias for the included patients. \(^{(23)}\) Participant were clearly informed with the whole treatment procedure and given time to consider the purpose and aims of the study; the likely risks, benefits, and discomforts associated with participation. Informed consent was taken from all patients regarding all treatment steps and also, the publishing of their clinical results and photographs. \(^{(24,25)}\) In cases where teeth destruction was extensive more than 50% of coronal loss, restoration was done by glass fiber post and composite core as fiber posts have been proved to aid in favorable distribution of forces applied over the core and restoration, moreover, in cases where destruction was minimal; 50% or more coronal structure was maintained, restoration was
done with only composite core. (26) All crowns fabricated in this study were done by one laboratory technician using one CAD/CAM system. 5-axis milling machine was used for production of all restorations to ensure proper restoration fitting, fewer manual finishing steps and smaller marginal gaps. (27,28) All crowns in this study were only polished not glazed following the manufacturer instructions using the manufacturer polishing kit according to the material used. Because of the great advances in polishing instruments, achieving an acceptable smooth surface have become possible by using rotary equipment. As several in vitro studies have reported that wear of the antagonist enamel significantly reduced when zirconia restorations surfaces are being polished not glazed. (5,20,21,7)

**Park et al. 2014** claimed that glazed and stained zirconia reported the highest volume loss while polished zirconia restorations reported the least loss of volume of the enamel. Different studies claimed that polished zirconia crowns, not glazed, cause reduce wear to the opposing natural tooth. In addition to that, zirconia with surface glaze has been shown to possess significant wear after 6 months period. (29,30) The method of evaluating the wear of the enamel antagonist was the replica technique as it was proved to produce accurate reproduction of the teeth surfaces as well as being easy to use and also it was claimed that measuring wear method by comparing sequential 3D images reported great accuracy. (3,31)

Moreover, it was reported that several clinical studies used these 3D measuring techniques, giving the advantages of 3D scanning of the whole surface of the tooth on the cast. Such techniques are quantitative highly accurate, viable to both the laboratory and the clinic as well as provides 3D databases which can stored that enable further comparison to another 3D database. Despite the advantage of the replica technique in quantifying the tooth structure loss it had some disadvantages which are repositioning problems and inaccurate replicas. (32) Epoxy resin casts were photographed in this study using USB digital microscope because of easier access, affordability, and reduced time. (33)

**In terms of evaluating antagonist wear:**

The study results showed that, monolithic zirconia showed statistically significantly lower mean surface roughness values (0.2530) of the antagonist compared to zirconia reinforced lithium silicate (0.2666), while no statistically significant difference was revealed between antagonist roughness values at different time measurement. This may be
due to the fact that monolithic zirconia has high surface hardness which when polished it retain the smooth polished surface when compared to any other ceramic material. (34,35) It could also be related to different materials’ composition, where monolithic zirconia is composed of compacted densely packed polycrystalline structure which tend to be more homogenous than that of the zirconia reinforced lithium silicate which is composed of different phases aligned together “glass phase and the polycrystalline inclusion”, this difference in structural composition maybe the reason of increase surface roughness of the zirconia reinforced lithium silicate over the monolithic zirconia. (27,32,36)

This finding agreed with Pathan et al 2019 who reported that zirconia monolithic crowns exhibit promising results in terms of enamel antagonist wear and clinical/survival performance. And their results were categorized as “excellent” over a 1-year period of follow up. (3)

Our results also came in accordance with the study made by Esquivel-Upshaw JF 2018 who reported that zirconia monolithic crowns exhibit similar enamel wear comparable to metal-ceramic crowns and control enamel after one year period. (34) As well as with Zhang et al 2019 who showed that stabilized zirconia ceramics with a higher yttria content and high-translucent, which were lately being developed in the dental field, became as opposing-friendly and wear-resistant as traditional zirconia with high strength and appropriate for monolithic full contour restorations. (37)

In addition, Fathy & Swain 2018 claimed that after zirconia reinforced lithium silicate ceramics stored in different ph media, the Ra (surface roughness) of the material increase differently which can cause significant wear of tooth enamel after a period equivalent to one year of functioning intraorally rather than the significantly higher surface Ra of similar ceramic types can produce. (38)

However, our findings were against Tang et al 2021 study that claimed that zirconia monolithic crowns can show antagonist teeth wear through early or occlusal contact significantly and the wearing amount is increased over that of natural teeth and progress by time. (39)

Yet it also disagreed with Rashid Habib et al 2019 who claimed that Zirconia Monolithic showed the increased roughness of enamel surface, then Ceramo-metallic, Lithium disilicate and Composite resin showed the least and close surface roughness of
their enamel antagonist, respectively. But this difference was not statistically significant. (40) In regard to the time factor, our findings were against a systematic review by Solá-Ruíz et al 2020 who demonstrated that zirconia monolithic single crowns lead to an increasing wear of the antagonist tooth with time which is higher than the maximum amount of wear present in the crown itself. (41)

Regarding the evaluation of the patient satisfaction at different time intervals:

The results showed changes by time within Monolithic Zirconia group in terms of general satisfaction and satisfaction with comfort; a statistically significant change was revealed in scores with time ($P$-value = 0.029, Effect size = 0.241). This could be explained by debonding of some crowns within this group which affected the satisfaction and comfort scores. The debonding happened in crowns over badly destructed, subgingival preparations where isolation was difficult to achieve. These scores were raised by the patients after immediately and properly cementing the restorations. While for satisfaction with the ease of cleaning within the ZLS group, changes by time were reported; a statistically significant change was revealed in scores with time ($P$-value = 0.029, Effect size = 0.241). These significant values maybe due to subgingival margins placement in some patients that were inaccessible for them to clean and properly using the dental floss, these values started to increase by time with proper patient education of hygiene measures. Whereas ability to speak, self-esteem and functionality reported “10” which is indicated for excellence, this could be due to accuracy and standardization in every step following the other and following the manufacturer instructions regarding type of the material used.

While for satisfaction with esthetics, monolithic zirconia group showed statistically significant lower median satisfaction with esthetics score than zirconia reinforced lithium silicate. This finding could be due to the fact that zirconia monolithic crowns tend to be opaque and lack the translucency and fluorescence when compared to zirconia reinforced lithium silicate ceramics, which has a unique complex microstructure; consists of lithium orthophosphate crystals and lithium metasilicate inserted in a glassy matrix having zirconia particles, such microstructure is claimed to support the outstanding optical properties of the material. (42,43)
This came in accordance with Sorrentino et al 2021 who demonstrated in their review that zirconia reinforced lithium silicate restoration exhibits satisfactory esthetics that indicate their use in anterior and posterior areas. (44)

CONCLUSIONS

Within the study limitations the following were concluded:

1. Polished monolithic zirconia is an enamel friendly restoration showing acceptable enamel wear behavior compared to zirconia reinforced lithium silicate.

2. No significant increase in enamel wear by time when opposed by properly polished zirconia and zirconia-based restorations.

3. Both zirconia and zirconia reinforced lithium silicate reported high scores of patient satisfaction throughout the follow-up period.

4. Monolithic zirconia restorations showed less satisfaction with esthetics compared to zirconia reinforced lithium silicate ceramic restorations.

RECOMMENDATIONS

1. Further clinical trials are recommended to evaluate long-term wear behavior of monolithic zirconia restorations compared to other ceramic types when opposed to natural enamel.

2. More clinical studies with larger sample sizes and different wear measuring methods to compare the enamel antagonist wear when opposed by different monolithic ceramic restorations are recommended.

3. Direct quantitative wear measurements methods by using intraoral scanning are further recommended in assessment of wear behavior to achieve maximum accuracy.
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