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Patient satisfaction and clinical assessment of surface roughness and wear of enamel antagonists for polished versus glazed posterior lithium disilicate glass ceramic crowns: A randomized controlled clinical trial

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Abstract---Aim: To compare surface roughness of glazed versus polished lithium disilicate crowns as well as wear of enamel antagonists. Methodology: Twenty-two full coverage crowns were fabricated for posterior teeth. Scaling and polishing was performed for all the patients one week prior to preparation. The patients were divided into two groups according to crown finishing. Group 1(control group) fabricated from IPS e.max glazed crowns and Group 2 (intervention group) fabricated from IPS e.max polished crowns. The preparation was standardized with supra-gingival, chamfer finish line for all teeth. Fabrication of the crowns was done using lost wax press technique. The restorations were glazed with e.max ceram glazing liquid; an even layer was applied on the entire surface of the crown using a brush. Polishing was performed using EVE abrasive rubbers. Polishing of each crown was performed with rubbers of three different grains, beginning with the most abrasive one (light crimson) for shaping, then an intermediate one (crimson) for pre polishing, and the last, a less abrasive one (yellow)for high shine polishing. Self-adhesive cement was used for both groups. Roughness of crowns as well as

opposing teeth wear were measured using non contact 3D profilometer, patient satisfaction was evaluated in the form of questionnaire. Results: Fisher's Exact test was used to compare between the two groups; there was statistical significant difference between mean SD at the two materials' sides where polished lithium disilicate crowns showed smoother surface than glazed lithium disilicate crowns. There was also statistical difference concerning opposing enamel wear where glazed lithium disilicate crowns exerted more enamel wear to opposing teeth than polished lithium disilicate crowns. No statistically significant difference between both groups regarding patient satisfaction (color, shape, ease of cleaning and chewing ability). Conclusions: Polished pressable lithium disilicate monolithic crowns are smoother than glazed crowns, both finishing protocols yield high patients' satisfaction and fine diamond is preferable to be used to polish lithium disilicate that have been adjusted; to make them wear compatible with enamel. Thus, this study was against the null hypothesis. Therefore careful checking of glazed occlusal surface one year post-cementation is recommended. Registration: NCT03696849.

Keywords---surface roughness, enamel wear, polished, glazed, lithium disilicate, patient satisfaction.

Introduction

Excellent physical properties of dental ceramics such as esthetics, low thermal conductivity, biocompatibility, and wear resistance made them able to imitate natural teeth [1,2]. Because of these features, dentists have widely used dental ceramics in several rehabilitation procedures, including onlays, inlays, porcelain veneers, and crowns [3,4]. However, as with any other restorative material, it has some drawbacks, like fragility under superficial stress, friability before cementation and possible wear of the antagonist dentition or restorative material [5,6]. The surface quality of a restoration is one of the most important aspects that figure their clinical success in the oral cavity. Restorations' surface quality is highly related to esthetic appearance, surface roughness, wear resistance, gloss, and mechanical properties of the restorations. [7,8].

Among these properties, surface roughness is to be considered as it has a major impact on the biofilm adhesion and maturation, gingival irritation, recurrent caries [9,10], and staining [11]. Moreover smooth surfaced restorations facilitate oral hygiene and assure patient comfort [10,12,13]. The ceramic surface is routinely exposed to a superficial treatment known as glazing which is performed with abrasive burs followed by a heat treatment that melts the superficial layer [1]. The glazing treatment seals the open pores on its surface after the firing process [14], which offers excellent optical properties and greater surface smoothness [15]. Thus, the ideal is that the glazed ceramic surface is to be kept intact in order to reduce the biofilm accumulation and to maintain its mechanical strength [14,16]. Nevertheless, this layer of glaze will be worn off by any required adjustment or shortly after insertion of the restorations. Even so, chair-side

modifications that necessitate refining cervical margins, adjusting occlusal contacts, and reducing proximal contours to provide interproximal contact areas; may induce rough surfaces [17].

The previous actions result in loss of ceramic restorations intact surface glaze which generates rougher surfaces, several periodontal problems and wearing of the opposing dentition. That's why reglazing should be performed but it will subject the ceramic material to another cycle of firing which may result in structural changes, in addition, it can be time consuming. So an alternative approach is polishing which can be done at the same patient's visit to reduce chair side time [18]. Therefore, there is general mediation among dentists that a final finishing and polishing procedure or re-glazing must be performed to roughened ceramic surfaces to prevent or at least minimize accelerated wear of the opposing dentition as well as to enhance restoration longevity and esthetics, by removing the defects produced after surface grinding resulted from adjustments [18]. Lithium disilicate ceramic materials (such as IPS emax. Press, Ivoclar Vivadent) have similar refractive indices to the glassy matrix, which consequently gave the material its suitable translucency for esthetic restoration [19]. A combination of translucent characteristics and suitable mechanical properties made this material able for application in the full anatomical posterior crowns without additional veneering porcelain [20]. The effect of different finishing procedures on the roughness of pressed ceramics as well as their effect on enamel antagonist wear were evaluated in this study.

Methods

Ethical considerations and approval

This study was approved by the Research Ethics Committee of the Faculty of Dentistry (Approval no:) Written informed consent regarding treatment sequence, publishing of their images and results was obtained from all participants.

Registration

This trial was registered at the ClinicalTrials.gov registry under registration number NCT03696849.

Study design

This study was a double blind randomized controlled clinical trial with a 1:1 allocation ratio. This article was written in concordance with the CONSORT checklist; a completed checklist is available on Open Science Framework.

Participants

All participants were recruited from the outpatient clinic of the Department of Fixed Prosthodontics of Faculty of Dentistry, Cairo University, Cairo, Egypt. A face-to-face participants' selection was performed according to the patients' need for a full coverage restoration on a posterior tooth. A total of 22 participants were recruited for this study. Full medical and dental history were obtained from all

participants. Treatment was completed by one operator (the researcher) who followed a strict clinical procedure; the operator followed the phases of full coverage fabrication: diagnosis, preparation design, temporization, construction of the material and cementation. Two groups (11 crowns in each group) were included in the study. The crowns were accomplished by one experienced dental technician.

Eligibility

Inclusion criteria

- Patients' age between 18-50 years old, they should be able to sign and read the informed consent document.
- Patients should be physically and psychologically able to stand for conventional restorative procedures.
- They should have no active pulpal, or periodontal diseases, have teeth with good restorations.
- Patients have no temporomandibular disorders.
- Each participant needed a crown on either a first or second molar or first or second premolar in any arch.
- Teeth selected should include:
 - Restorability with a crown: root ratio of minimum 1:1.
 - Presence of an opposing natural tooth which was non-restored.
- Patients are able to return for follow-up examinations and evaluation.

Exclusion criteria

- Patients in the growth stage with partially erupted teeth.
- Patients with poor oral hygiene and motivation.
- Pregnant women.
- Unrealistic or Psychiatric problems or expectations.
- Lack of opposite occluding dentition in the area intended for restoration.
- Patients with parafunctional habits.

Sample size

Using independent t test and assuming an effect size of 1.35, a type I error of 0.05 and a power of 0.8, a sample of 20 subjects (10 for each group) is required to detect a significant difference between the two groups regarding the amount of tooth wear. For a possible drop-out rate of approximately 10%, the sample size was increased to 22 subjects (11 for each group). The sample size was calculated using the G*Power software version 3.1.9.2.

Randomization

Randomization was carried out using computerized sequence generation (<https://www.randomizer.org/>) in the Center of Evidence Based Dentistry, Cairo University. Participants were divided into two groups (A and B) according to the surface finishing used. Each participant received a sealed opaque envelope with their randomized number.

Allocation concealments

Number for each member in each group was written by indispensable pen on large white paper sheet. The sheet was folded eight times and saved inside opaque well sealed envelope.

Implementation

The candidate under supervision was responsible for providing allocation generation and dividing patients into two groups and save it in the envelopes in secured place until the date of performing procedure.

Blinding

The trial participants and outcome assessors were blinded throughout the whole procedures (double blind), as the dentist practitioner (M.M.) was responsible for all clinical procedures.

PICOTS

- Population (P): Patients require single full coverage restoration in posterior area.
- Intervention (I): Polished lithium disilicate ceramic crown (IPS e.max – Ivoclar Vivadent)
- Comparator (C): Glazed lithium disilicate ceramic crown (IPS e.max –Ivoclar Vivadent)
- Outcome (O): Outcome name, measuring device and measuring unit are shown in table ()

Table 1
Outcome measures, measuring method and measuring unit

Outcome name	Measuring method	Outcome unit
<u>Primary outcome:</u> Antagonist enamel wear	Profilometer	Volume loss in μm^3
<u>Secondary outcome:</u> Restoration surface roughness	Profilometer	Ra in μm
<u>Secondary outcome:</u> Patient satisfaction	Questionnaire Visual Analog Scale (VAS)	Binary (yes or no) Then numerical(discrete) from “0” unsatisfied to “10” satisfied.

Time (T): One year

Study Design (S): Randomized controlled clinical trial

Intervention**Diagnostic and preparatory phases**

Remaining tooth structure, occlusal scheme, oral hygiene, periodontal condition, dental caries and parafunctional habits were assessed for dental examination. Periapical radiograph was taken for each patient to assess the quality of the endodontic treatment, alveolar bone level and crown/root ratio. Scaling and polishing were performed for each patient in for improving the oral hygiene level and allowing accurate shade selection.

Tooth preparation phase

Orientation grooves were done on the occlusal, buccal and lingual surfaces of the tooth to standardize the amount of the preparation and ensure equal thickness of the restorative materials. A tapered diamond stone with a round end (859-314-010, Komet, Germany) was used to do a chamfer finish line with 0.8-1mm thickness as shown in figure(1).



Figure 1. Tooth preparation

Impression making phase

Final impressions were taken using Polyvinyl siloxane (PVS) addition silicon (Express STD, 3 M, U.S.A) in stock trays.

Master cast construction

Impressions were poured with type IV dental stone (GC FUJIROCK EP, GC, U.S.A.) according to manufacturer's instruction.

Fabrication of emax Press crowns

A fully anatomical wax pattern (Star Wax, Dentaaurum, Germany) was obtained using electric wax instruments. A wax sprue of 3mm diameter and 5mm length was attached at the thickest part of the pattern. A small brush was used for the fine investment of the fitting surface then the investment (IPS PressVEST) was poured to fill the ring. The conventional preheating furnace was heated to 850°C and the investment ring was then for wax elimination. The investment ring with

the ingot and the Alox plunger were placed in the center of the EP600 press furnace. Divesting and then finishing were performed according to manufacturer instructions.

Glaze firing and Polishing

- Glaze firing (Comparative Group) Crowns of this group were subjected to glaze firing using glaze powder mixed with e.max ceram glazing liquid (emax glaze powder, Ivoclar Vivadent, Germany) and an even layer was applied on the entire surface of the crown using a brush. Then, the glaze firing was carried out according to manufacturer's firing parameters.
- Polishing (Intervention Group) Crowns of this group were submitted to polishing with Eve rotary grinding and polishing kit (Eve rotary polishing kit, Germany) shown in figure (2). Each specimen was polished with rubbers of three different grains, beginning with the most abrasive one for the pre-polishing, then an intermediate one for polishing and the last, a less abrasive one for high brightness polishing.

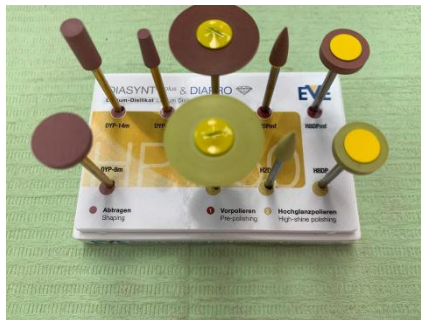


Figure 2. EVE polishing kit

Cementation

A prophylaxis paste and polishing brush was used for cleaning the tooth surfaces prior to bonding to remove any remnants of provisional cements, while The internal surface of the e.max crown was etched for 20 seconds with 9.5% buffered hydrofluoric acid (Dentobond porcelain etch) then the crown was rinsed with water for 20 seconds then air dried. A single coat of the ceramic silane (Dentobond porcelain silane) was then applied and left for 1 minute then air thinned. Finally, the luting resin cement (SET PP, Australia) was applied to the fitting surfaces of the crown and the crown was cemented to the tooth.

Replica fabrication

Sectional stock trays were used for making two quadrant impressions (one for the quadrant where the crown was placed and the other for the opposing quadrant dentition) immediately after cementation of the crowns and again every 2 months for 1 year with a vinyl polysiloxane impression material by the use of dual viscosity technique.

Primary and secondary outcome measurement (enamel wear and surface roughness)

The optical methods tend to fulfill the need for quantitative characterization of surface topography without contact. A high-resolution noncontact surface profilometer was used to optically scan the total occlusal surface of each crown and its antagonist teeth replica in 3D.

Secondary outcome (Patient Satisfaction)

The two groups were evaluated every two months up to one year for patient satisfaction about the color of the crown using Visual Analogue Scale (VAS) which is documented in chart including number of satisfied and unsatisfied. The VAS scale ranged from zero to ten where zero means the least satisfaction with color and ten means the maximum satisfaction concerning shape, color satisfaction, chewing ability and ease of cleaning.

Statistical analysis

Data were presented as mean, standard deviation (SD), median and range values. For parametric data; Student's t-test was used to compare between the two techniques. For non-parametric data; Mann-Whitney U test was used to compare between the two techniques. We used Friedman's test to study the changes by time within each group. Qualitative data were presented as frequencies and percentages. We used Fisher's Exact test to compare between the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY:IBM Corp.

Results

Concerning surface roughness; there was no statistically significant difference between the two groups (P -value = 0.158, Effect size = 0.631) after two months. At all other follow up times; polished crowns showed statistically significantly lower median surface roughness values (Ra) than glazing (P -value = 0.045, Effect size = 0.944), (P -value = 0.049, Effect size = 0.926), (P -value = 0.018, Effect size = 1.167), (P -value = 0.009, Effect size = 1.327) and (P -value = 0.025, Effect size = 1.082), respectively. Table(2). Figure (3)

Table 2
Descriptive statistics and results of Mann-Whitney U test for comparison between (Ra) values (μm) of the two techniques and Friedman's test for comparison between follow up times (Crowns)

Time	Polishing		Glazing		<i>P</i> -value (Between techniques)	Effect size (<i>d</i>)
	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)		
2 months	0.0654 (0.0711)	0.0223 (0.0005-0.2152)	0.1117 (0.0793)	0.0748 (0.011-0.22)	0.158	0.631
4 months	0.0508 (0.0686)	0.026 (0.0008-0.2388)	0.1503 (0.1243)	0.1114 (0.0008-0.4223)	0.045*	0.944
6 months	0.057 (0.0552)	0.0271 (0.002-0.1658)	0.1671 (0.1425)	0.1288 (0.0117-0.5005)	0.049*	0.926
8 months	0.0525 (0.0479)	0.0282 (0.0016-0.1488)	0.1664 (0.1357)	0.1458 (0.0047-0.4753)	0.018*	1.167
10 months	0.0565 (0.0907)	0.0411 (0.0018-0.3241)	0.161 (0.1206)	0.1915 (0.0276-0.3241)	0.009*	1.327

12 months	0.0818 (0.0883)	0.0407 (0.0097-0.2565)	0.1731 (0.091)	0.1938 (0.0231-0.3056)	0.025*	1.082
<i>P</i> -value (Between times)	0.990		0.271			
Effect size (<i>w</i>)	0.01		0.116			

*: Significant at $P \leq 0.05$

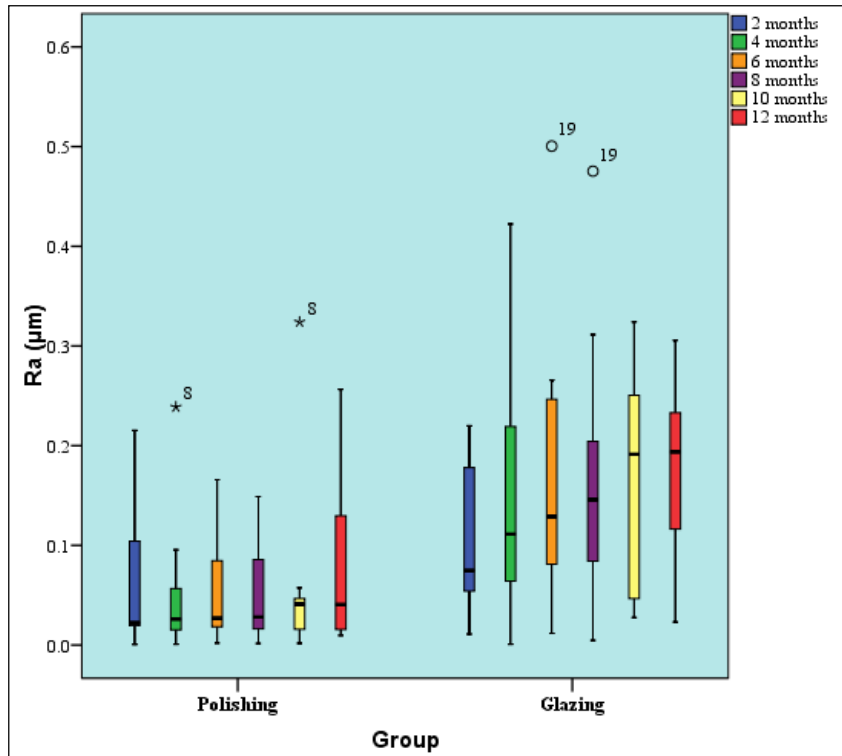


Figure 3. Box plot representing median and range values for (Ra) of the two techniques at each follow up period (Crowns) (Circles and stars represent outliers)

Concerning opposing tooth enamel wear; polished crowns resulted in statistically significantly lower median volume loss in the opposing teeth than glazed ones (P -value = 0.023, Effect size = 1.103), (P -value = 0.010, Effect size = 1.303), (P -value = 0.001, Effect size = 1.922), (P -value = 0.028, Effect size = 1.062), (P -value = 0.006, Effect size = 1.428) and (P -value = 0.003, Effect size = 1.593), respectively at all follow up times. Table(3). Figure(4).

Table 3
Descriptive statistics and results of Mann-Whitney U test for comparison between volume values (μm^3) of the two techniques and Friedman's test for comparison between follow up times (Opposing tooth)

Time	Polishing		Glazing		P-value (Between techniques)	Effect size (<i>d</i>)
	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)		
2 months	0.0383 (0.037)	0.0215 (0.0026-0.0992)	0.1233 (0.106)	0.0947 (0.0094-0.3315)	0.023*	1.103
4 months	0.057 (0.0509)	0.0381 (0.0087-0.145)	0.1855 (0.1382)	0.1856 (0.0129-0.417)	0.010*	1.303
6 months	0.0554 (0.033)	0.0552 (0.0013-0.0985)	0.2169 (0.1207)	0.1972 (0.0413-0.4552)	0.001*	1.922
8 months	0.0608 (0.0556)	0.0382 (0.0037-0.1625)	0.2082 (0.1586)	0.2037 (0.0036-0.4909)	0.028*	1.062
10 months	0.0917 (0.08)	0.0524 (0.0156-0.2432)	0.2315 (0.1288)	0.2207 (0.056-0.4405)	0.006*	1.428
12 months	0.098 (0.0747)	0.0792 (0.0143-0.2316)	0.2544 (0.1126)	0.2014 (0.1218-0.4876)	0.003*	1.593
P-value (Between times)	0.059		0.061			
Effect size (<i>w</i>)	0.177		0.17			

*: Significant at $P \leq 0.05$

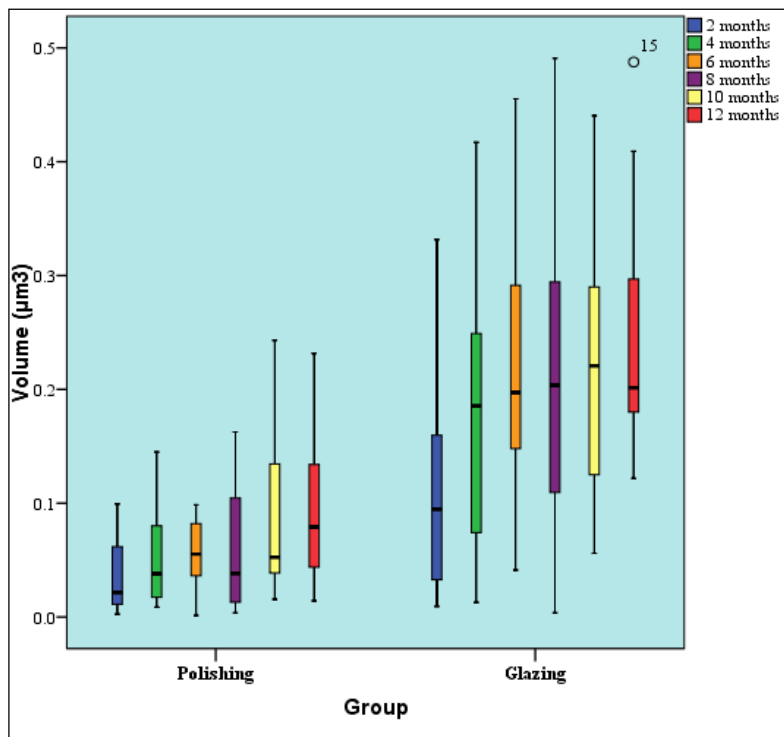


Figure 4. Box plot representing median and range values for volume of the two techniques at each follow up period (Opposing tooth) (Circle represents outlier)

Regarding patient satisfaction, there was no statistically significant difference between the two techniques and also at different follow up times within each technique concerning shape, color, ease of cleaning and chewing ability. Table(4). Figure (5).

Table 4
Descriptive statistics and results of Mann-Whitney U test for comparison between satisfaction with chewing ability in the two groups and Friedman's test for comparison between satisfaction scores at different time periods within each group

Time	Polishing (n = 11)		Glazing (n = 11)		P-value	Effect size (d)
	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)		
Base line	8.27 (1.62)	8 (6-10)	8.18 (0.98)	8 (6-10)	0.864	0.07
2 months	8.82 (1.17)	9 (7-10)	8.45 (0.69)	8 (8-10)	0.333	0.4
4 months	8.82 (1.17)	9 (7-10)	8.27 (0.79)	8 (7-10)	0.202	0.536
6 months	8.82 (1.17)	9 (7-10)	8.27 (0.79)	8 (7-10)	0.202	0.536
8 months	8.36 (0.92)	8 (7-10)	8.09 (1.04)	8 (6-10)	0.530	0.254
10 months	8.36 (0.92)	8 (7-10)	8.09 (1.04)	8 (6-10)	0.562	0.254
12 months	8.36 (0.92)	8 (7-10)	8.09 (1.04)	8 (6-10)	0.562	0.254
P-value	0.570		0.526			
Effect size (w)	0.073		0.073			

*: Significant at $P \leq 0.05$

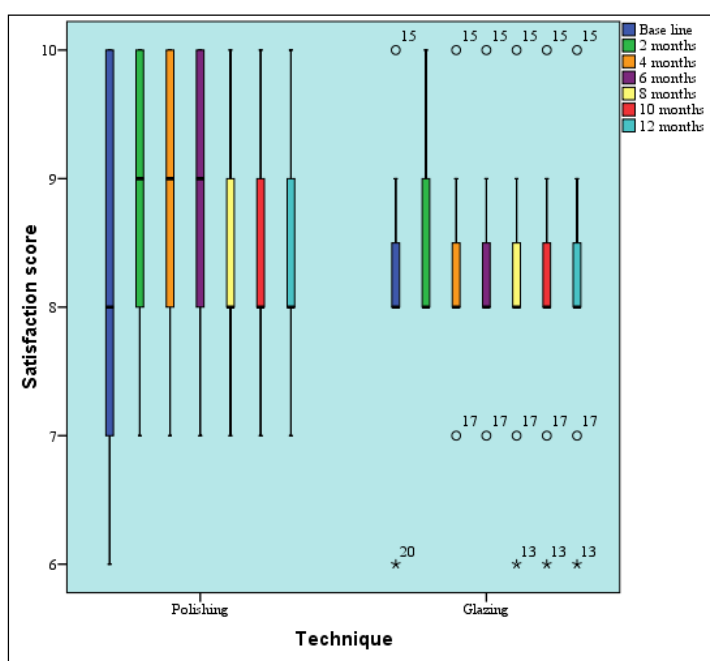


Figure 5. Box plot representing median and range values for satisfaction with chewing ability in the two groups (Circles and stars represent outliers)

Discussion

It is routinely necessary to harmonize the ceramic restorations before cementation to assure that their surface texture and contour are similar to the natural dentition, and also to keep proper occlusion [21,15,22,23]. These modifications usually make the surface of this material inconsistent with the oral tissues

[4,14,15,22]. So, it is critical for the ceramic to receive some type of finishing and polishing protocols in order to obtain a smooth surface [24]. Delineated loss of the glaze layer or roughening of polished surfaces are the result of ceramic surfaces grinding, the subsequent use of a polishing set is a well-settled method, but is not applied by all dentists. Differences in physical properties and composition of restorative materials and tooth substances lead to differential wear with time. This mismatch of wear rate may lead to either excessive wear of the natural dentition or the opposing restorative material and may cause tooth sensitivity, occlusal destabilization, or loss of esthetics [25,26,27,28]. Therefore, the influence of restorative materials on the wear of natural dentition should be assessed.

There is a difference between the mechanism of wear of veneering porcelain and that of high strength ceramics like zirconium oxide and lithium disilicate. Veneering porcelain fractures during wear and makes sharp asperities on its surface which cause opposing enamel abrasion. Additionally, these fractured fragments of porcelain may play the role of third-body particles, further accelerating the wear process.[29] Monolithic single tooth restorations in anterior and posterior regions were allowed to be fabricated by lithium disilicate glass ceramics due to the large amount of embedded lithium oxide crystals in an interlocking manner in a glassy matrix, although, their mechanical properties do not come up to high-strength zirconia [30]. One of the advantages of using monolithic restorations include a conservative preparation as there is no need to keep space for the veneer porcelain. Furthermore, the technique sensitive procedure of veneering is also excluded [31].

The wear of enamel against ceramic crowns antagonists have only been analysed by in vitro studies. Wear machines cannot imitate complex masticatory movements which is the main limitation of those studies. Chewing patterns differ between individuals and are dependent on multiple factors such as joint dyscrasia, muscle tone, oral health and so on [32,33]. The 22 patients were divided into 2 groups randomly to avoid the risk of selection bias. For the control group the teeth received glazed IPS e. max restorations in posterior area. While polished IPS e.max restorations were received by teeth in the posterior area for the intervention group. Full coverage preparations were performed by preparing the tooth according to manufacturer's guidelines for pressable lithium disilicate crowns with a supra-gingival chamfer finish line 1 mm deep with round internal angles, occlusal reduction of 1.5-2 mm and axial reduction of 1.5mm. In order to standardize our preparation design depth cuts were performed to ensure uniform reduction [34].

After the crowns had been tried in patients' mouth, unavoidable occlusal adjustments and in some cases proximal adjustments were performed; the fine grain diamond points are recommended to do the adjustments of these restorations [15,23,35,36] because (Mitov et al 2012) [31] showed in their study that the amount of opposing enamel wear is affected by the grit of the diamond bur used to adjust ceramic restorations. A fine diamond bur produced similar opposing enamel wear as polished ceramics and less enamel wear than ceramics adjusted with a coarse diamond bur. Nevertheless, the roughness on the surface of the restorative material caused by these instruments; must be reduced by reglazing or repolishing according to the initial crown state [23,36]. Concerning

the glazed crowns group; the overglaze was applied using a brush to ensure a thin, single and uniform layer applied by the same technician and fired at 400°C entry temperature, 730°C high temperature for 1 minute to assure standardization. In this study overglaze was used and not autoglaze as applied glaze was proved to reduce the depth and/or sharpness of the critical flaws, acted as a sealant and could flow in to the surface flaws on the ceramic surfaces [37].

Concerning the polished crowns group; the material used has a great effect on the choice of the type of abrasive particle and the application technique, because the finer the particles and the larger number of steps (which can be three or four steps) used the better will be the final polishing outcome [23,36]. That's why EVE diamond impregnated polishing kit was used in this study. This kit is suitable for polishing of lithium disilicate; our material of choice. It consists of three different grit sizes (medium, fine and ultrafine) to assure highly lustrous surface. Each grit size has different shapes as disc, point and wheel to reach every minute detail on the occlusal surface. Although manual polishing results in a significantly lower surface gloss than machine polishing, we selected manual polishing to simulate clinical conditions [38]. After crowns cementation, an indirect method was used for measuring roughness of crowns as well as wear of opposing enamel by making quadrant impressions of the teeth and producing a replica in type IV dental stone at 2,4,6,8,10 and 12 months. These replicas were then compared using a non contact 3D profilometer.

Superficial analysis and screen of glass ceramics was allowed by measuring roughness with regard to their surface characteristic after being finished [39]. Surface roughness can be described by several linear (R_q , R_a) or three-dimensional (S_z , S_q , S_a) parameters [40,41,42]. For the present study, R_a , which can be defined as the mean arithmetical value of all the absolute distances of the profile inside of the measuring length [43] was measured because it is the most commonly used parameter for evaluating the effect of finishing protocols on dental ceramics [44,45]. Quantitative assessment of tooth wear has most often been assessed using surface profilometry. This has the benefit of being simple to understand, reasonably straightforward to conduct, as it allows a step measurement (in microns) of surface roughness and enamel loss. [46]. (Rodriguez et al. 2010) [47] demonstrated that the 3D analysis provided more sensitivity maybe due to scratches induced by the stylus of contact profilometry.

Regarding the methods used in this study, measuring wear was performed by 3D scanning of cast replicas and superposition of occlusal surfaces (3D matching), which recently seems to be the most feasible and accurate method with good reproducibility [48]. Patient satisfaction was also used as an outcome in this study as several authors have reported discrepancies between the treatment needs received by patients and those assessed by dental professionals. The results of our study proved that polished emax Press crowns showed less surface roughness than glazed crowns. The higher surface roughness values (R_a) reported in glazed crowns compared to polished ones might be due to the fact that the glaze layer is of 20-50 μ m; this layer is weaker and softer than the bulk high strength ceramic and can be easily worn away within six months to one year of function [39,49,50]. At this point, the underlying surface of the ceramic becomes

exposed to the oral environment, which showed rougher surface than polished crowns.

In addition, the glazed surfaces are not flat, with many irregularities [2,50] because of tiny protrusions of glaze particles and voids which are believed to negatively affect the surface properties of ceramic materials [51,52]. Concerning wear of enamel antagonists; the results of our study demonstrated that the use of polished emax Press crowns showed less wear of enamel compared to glazed emax Press crowns. This might be due to the fact that after being worn away of the weak glaze layer as explained before the higher roughness of the underlying surface becomes most important for producing wear of enamel antagonists [2,50]. Additionally, worn particles from the glaze layer may act as third-body abrasives. Therefore, the higher wear of glazed ceramics can be explained by the removal of the soft glazed surface, and the greater wear of opposing natural enamel can be explained by its contact with rough ceramic subsurface [50].

Our results were in accordance with those of (Janyavula et al 2013)[50] and (Zandparsa et al 2016)[53] who have shown that less wear on enamel antagonists was produced by polished ceramics than glazed ceramics. (Kim et al. 2012)[54] reported that the rate of enamel wear was dependent on the surface roughness of ceramics, he proved that ceramics subjected to polishing produce less enamel wear than those subjected to glazing. (Park et al.2014)[55] concluded that polished ceramics showed the least volume loss of enamel while the glazed and stained ceramics showed the highest volume loss. These studies demonstrated that polished ceramic full coverage crowns, cause less wear to the antagonist natural enamel than glazed crowns. In addition, the glazed ceramic surface has been demonstrated to have significant wear after 1 year, as reported by (Jung et al 2010)[56] (Park et al 2014)[56] and (Etman et al 2009)[49].

(Bassir et al 2016)[57] also stated that roughness measurements indicated that the finishing and polishing procedures of monolithic lithium disilicate ceramics, especially with OptraFine system, gave smoother and more uniform surfaces when compared to glazing and reglazing so they concluded that roughness of glazed crowns was greater than roughness of polished crowns. Our findings are also in agreement with the results of a study by (Alhabdan and El-Hejazi 2015) [58], who discussed that with advances in polishing instruments and techniques, it is now possible to reach acceptably smooth surfaces with rotary equipment, in their study polished crowns showed less surface roughness than glazed crowns. (Selvaraj et al 2020) [59] showed that polished and glazed ceramic crowns caused more wear in opposing natural enamel than natural enamel antagonists, with the greatest wear caused by glazed crowns which is in agreement with our study.

At the same time these results were against (Barghi et al.1975)[16] and (Karaksi et al. 1993) [21], who stated that the ideal is to keep the glazed surface safe because the glaze producing regular and smooth surfaces which provide less wear of antagonist dental enamel, greater mechanical strength to the material, and less biofilm aggregation (Al Wahdani et al 1998) [14]. (Patterson et al. 1991)[23] and (Al-Wahadni 1998) [14] stated that specimens that were subjected to glazing produced less surface roughness, when compared with different finishing and polishing techniques which may be due the change of ceramic material used. Also

the study by (Stober et al 2014) [48] stated that the specimens that were subjected to glazing presented the lowest surface roughness values (Ra) if compared with the other finishing and polishing protocols, for all the types of ceramics which may be due to difference in sample size. Our results also was against (Abu Jalala et al 2019) [60] who concluded that polishing ceramic restorations had negative effects on the antagonist wear while crowns that were subjected to glazing showed the lowest antagonist wear which may be due to difference in material of choice.

However, (Kelly et al. 1996)[61] , (Sarac et al. 2006) [35] , (Esquivel-Uphsaw et al 2018) [33] affirmed that there was no statistically significant difference between antagonist enamel wear as well as the surface roughness values found for the ceramics that were subjected to glazing and the ceramics that were subjected to polishing with different polishing protocols. Also (Lawson et al 2014) [62] found no significant difference between polished and glazed lithium disilicate concerning antagonist enamel wear. Concerning patient satisfaction there was no statistically significant difference between median satisfaction scores in the two groups. As regards the changes by time within each group; there was no statistically significant change in satisfaction outcomes by time.

Conclusions

Within the limitations of this study, the following conclusions could be drawn as follows:

- Polishing of monolithic pressable lithium disilicate crowns yields smooth surface with less roughness than glazed crowns.
- Polished monolithic pressable lithium disilicate restorations are more enamel friendly than glazed crowns as they showed less wear of enamel antagonists than glazed crowns.
- Both finishing protocols; glazing and polishing, yield high patient satisfaction concerning shape, color, ease of cleaning and chewing ability.

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