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FIXED PROSTHODONTICS AND DENTAL MATERIALS

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EFFECT OF STORAGE MEDIA ON THE MARGINAL ADAPTATION AND ELEMENTAL ANALYSIS OF PEEK AND TESSERA VONLAYS

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ABSTRACT

Aim: Evaluation of the effect of storage media on the marginal adaptation and elemental analysis of PEEK and TESSERA vonlays.

Materials and Methods: 24 vonlays were constructed. Samples were divided into two groups according to the material of construction (n=12). Group A was fabricated of CEREC Tessera™ blocks and Group B was constructed of breCAM.BioHPP bredent milling disk. Each group was subdivided into two subgroups (n=6) according to storage media they were subjected to: Subgroup (P1) was immersed in acidic media and Subgroup (P2) was immersed in artificial saliva. The samples were subjected to thermal aging. Marginal adaptation was measured after cementation using a stereomicroscope. Samples were analyzed using an environmental EDX. Testing procedures were performed before and after immersion in storage media.

Results: The statistical analysis for PEEK, TESSERA revealed no significant changes in marginal gap in artificial saliva for PEEK (p=0.506) for TESSERA (p=0.489), but a significant change was observed in acidic media for PEEK (p=0.012). for TEESERA (p=0.018) The marginal adaptation values and ranges differ between TESSRA and PEEK, suggesting material-specific responses. PEEK consistently demonstrated higher marginal adaptation values compared to TESSRA, both before and after immersion. PEEK and TEESERA elemental analysis results showed substantial elemental composition modifications in multiple elements in acidic media.

Conclusion: This study concluded that PEEK, TESSERA showed statistically significant difference, indicating substantial variations in marginal adaptation and elemental analysis between the two materials across both artificial saliva and acidic media.

KEYWORDS: Elemental analysis–marginal adaptation– storage media –PEEK –Vonlays – Tessera

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INTRODUCTION

From the classic metal posts and cores to fiber posts and cores to partial coverage restorations that adhere to the tooth structure, post-endodontic restorations have seen significant development. There are two main types of fixed dental prostheses: the traditional kind, which relies on mechanical or frictional retention, and the more modern type, which is called minimally invasive MI or adhesive restorations, which rely on adhesives.

Tissue preservation is the cornerstone of contemporary dentistry. The development of treatment alternatives that more closely match the biological, biomechanical, and cosmetic objectives of so-called “minimal invasive” dentistry has been made possible by an understanding of the importance of tissue preservation and the advancement of biomaterials. In the dentistry sector, partial coverage restorations have been established in an effort to implement the conservative preparation concept, which calls for minimal tooth preparation to improve mechanical resistance and retention forms. [2, 3]

Veneer-lay, also known as Volnay, is a combination of an extended veneer and an onlay used to cover the buccal surface of premolar teeth where bonding to enamel is desired. The cusped teeth, often the maxillary premolars, are recommended for veneerlay. It is appropriate when the buccal cusp requires covering due to discoloration or disfigurement. The state of the marginal adaptation to the abutment teeth determines how long fixed prosthodontics last. [4]

One of the most promising is lithium disilicate because of its exceptional optical qualities, great mechanical strength, and acceptable medium and long-term survival. It makes it the ideal material for indirect restorations in the posterior sector since it permits the use of the material for both the aesthetically pleasing anterior sector and as monolithic inlays in posterior teeth. [4]

In 2021, Cerec Tessera CAD/CAM material was first made available on the market. It saves both the operator’s and patient’s precious time by providing greater aesthetics through a quick processing approach. It has a strong defining strength of up to 32 percent. The new lithium disilicate CAD/CAM blocks (Tessera, Dentsply Sirona) that were introduced to the prosthodontic field were represented by this substance. The main characteristic that sets this ceramic apart is how rapidly it can be altered. The glaze firing takes just four and a half minutes, this fast-firing time was attributed to the new composition of the ceramic composed of disilicate of lithium and virgilite, a lithium aluminium silicate. It has several indications such as the anterior and posterior region for crown, inlay, onlay, and veneer. [5]

Polyetheretherketone (PEEK), a high-performance polymer with beneficial mechanical, chemical, and physical properties, is used by dentists. PEEK has been proposed for a range of fixed and removable dental prostheses created with CAD-CAM technology. Additionally, PEEK was recommended for intra-radicular posts, occlusal splints, customized healing abutments, implant abutments, and temporary restorations. However, there were very few clinical trials located. [6, 7]

The longevity of fixed prosthodontics depends on the condition of the marginal adaptation to the abutment teeth. Marginal gaps can form a favorable condition for biofilm deposition, thereby contributing to the development of caries and periodontal diseases. Moreover, regardless of the sort of cement, large gaps increase the wear of the cement regardless of its kind.[7, 8]

In order to guarantee the efficacy and safety of different dental products, elemental analysis of dental materials is a crucial component of contemporary dentistry. As new tools and methods were created to perform these tests, the practice of elemental analysis of dental materials expanded over the 20th century. By precisely identifying and measuring the different components found in dental materials, these methods give scientists and dentists a comprehensive understanding of their composition and characteristics. [5]

So, the aim of this study was to evaluate the effect of storage media on the marginal adaptation and elemental analysis of PEEK and TESSERA vonlays.

The null hypothesis of this study is that there would be no difference in the marginal gap of PEEK or Tessera vonlays when immersed in different storage media.

MATERIALS AND METHODS

Sample size calculation:

The minimum sample size is determined based on a prior study that sought to evaluate the marginal accuracy of two ceramic types: Celtra Duo and IPS Emax CAD onlays used for the restoration of maxillary premolars. El-Naggar et al. (2023). 9According to this study, the minimum required sample size was found to 12 specimens per group (subgroups=2) (Total sample size=24 specimens). Any specimen loss from the study sample due to processing error was replaced to maintain the sample size. Group A(vc): vonlay samples (n=12) were fabricated of CEREC Tessera™ blocks (Dentsply Sirona, Milford, USA)), Group B(ve): vonlay samples (n=12) were fabricated of bre CAM.BioHPP bredent milling disk (© bredent, Germany). Each group was subdivided into two subgroups according to storage media. (P1) was immersed in acidic media, (P2) will be immersed in artificial saliva.

- Software

The sample size was calculated using GPower version 3.1.9.2[10]

Natural teeth selection and preparation:

Natural tooth selection:

A freshly extracted natural tooth, resembling the configuration of an upper first premolar, was chosen. The remaining soft tissue was eliminated using an ultrasonic scaler, and the tooth was subsequently disinfected.

Inclusion criteria

Extracted human maxillary premolar free of dental caries or restoration.

Exclusion criteria

1- Teeth with fractured roots

2- Teeth with lesions or fractured extending to apical to the cement-enamel junction

3- Teeth with visible cracks

4- Endodontically treated teeth

5-Teeth with internal or external resorption

Natural tooth preparation:

For standardization of preparation, CNC (Computer Numerical Control) (Premium Imes. ICore. Germany) (Computer Numerical Control) milling machine was used to prepare the teeth. The tooth was prepared according to regular dimensions of all ceramic vonlay restorations preparation guidelines with an occlusal box with 1/2 of the buccal-lingual distance and a depth of 2 mm ,2 mm occlusal reduction of the functional cuspid with the preparation extended 2 mm in the cervical direction at the lingual surface all these done using CNC. [11]

Prior to preparation putty index was done using panasil putty material (KETTENBACH GmbH and Co. KG, Eschenburg, German) addition silicon material to guide and judge the preparation. After the reduction of the facial surface, the proximal and occlusal surface all of the line angles and the gingival margins were rounded and finished. To create a perfect smooth surface the Jota Arkansas stone 649 (Jota Dentistry, Swiss) was used. **Figure (1)**

Optical impression of the teeth:

The teeth were digitalized by optical scanning using inEos X5 sirona extra oral scanner (Dentsply

Fig. (1) Natural tooth vonlay preparation

Sirona, Milford, USA). The teeth were sprayed with Cerec Optispray (Dentsply Sirona, Milford, USA) to improve the accuracy of the impression by eliminating optical highlights and achieving a consistently reflective surface. The precision of the scan was checked to ensure a complete digital model of the tooth has been created without defects.

Computer aided restoration designing:

The margins of the prepared teeth were delineated and marked utilizing Sirona inLab CAD Software. The insertion path was determined to initiate the design of the restoration, followed by the selection of materials to be milled from the software's library (Dentsply Sirona, Milford, USA). The cement space was adjusted to 60 micrometers, and the restoration dimensions were delineated on the design window to alter the fissure depth, cusp heights, buccolingual and mesiodistal dimensions, as well as the thickness of the restoration. 5-Computer-aided milling of the restorations was then performed.

Milling was accomplished using:

Sirona MC XL milling machine (Dentsply Sirona, Milford, USA) using **CEREC Tessera™ blocks**

Sirona MC X5 (Dentsply Sirona, Milford, USA) to mill **breCAM.BioHPP** bredent disk

12 **CEREC Tessera™ blocks** with block size C14 shade A2 HT were utilized. Each block was placed into the workpiece spindle and secured, along with the block holder.(wet system)

breCAM.BioHPP bredent disk bleaching shade was used. **breCAM.** The disk was inserted into the work piece spindle and tightened with the disk holder. (Dry system) Milling of CEREC Tesseract™ blocks was done under wet conditions that took approximately 15min per milling cycle. Milling of breCAM.BioHPP bredent disk was done under dry conditions that took approximately 30 min per milling cycle.

After the milling procedure was completed, each vonlay was examined for defects, removed from the blocks with care and then placed onto the teeth to verify marginal accuracy and eliminate any discrepancies using a sharp probe and magnifying loupes with 3. 5x magnification. The thickness of the restoration was subsequently measured with a conventional caliper. (Generic, Pakistan) to ensure that the preset thickness was maintained.

Bonding procedure:

The intaglio of all vonlays surface treatment: according to the manufacturer instructions which are the same for the two groups of restorations the following was done:

Using mini sponge hydrofluoric acid 9.5% (Bisco, Inc Bisco, USA) The fitting surface of each

TESSERA vonlay was treated for 20 seconds and subsequently rinsed with a strong water spray for an additional 20 seconds. Then Single layer of silane coupling agent (Inc porcelain primer, Bisco, USA) was applied to the fitting surface using mini brushes and allowed to react for 30 seconds then air dried with oil free air spray that for TESSERA vonlay but for PEEK visio. Link (Bredent, Germany) was selected after sandblasting the peek surface adding viso link primer on the inner surface of PEEK vonlay.

Surface treatment of teeth by using acid etch. For the treated tooth surfaces, a 37% phosphoric acid etchant gel (meta etchant, Metabiomed, Korea) was utilized for a duration of 30 seconds, followed by a thorough rinsing and air-drying process. A light-cure adhesive bonding agent (BISCO Inc, USA) was then applied to the etched surfaces using a micro-brush, allowed to sit for 30 seconds, and subsequently air thinned before being light cured for 20 seconds with a lighting unit. Dual cure self-adhesive resin cement (Breeze, Pentron, USA) was used to bond the vonlays. Auto-mixing tips were used according to the manufacturer recommendation; cement material was dispensed into the intaglio of each vonlay along the axial walls.

Each vonlay was positioned on its respective die, and a load of 5 kg (50 N) was exerted on the occlusal surface of each vonlay utilizing a specially engineered cementation apparatus.

Cementation loading procedure:

A specially constructed loading device was used during cementation of each vonlay to ensure standard load application, this loading device consists of two horizontal plates attached with two rigid vertical rods.

Polymerization was initiated by light curing (iled woodpecker, China) for two seconds to allow removal of excess cement around the margins of the restorations using sharp explorer, then a layer oxyguard (PANAVIA F2.0 OXYGUARD II, Kurary Co, Japan) was applied around the margins of the Volnay.

Thermal aging:

Thermo cycling was applied to samples in a specially designed device which consist of 4 tanks with deionized water at standard temperature. All samples were subjected to 5000thermocycles to represent approximately 6 months of clinical use. The samples were immersed for 15 seconds in each tank according to the following sequences: 5 C to 37 C to 55 C to 37C according to ISO 11405 standards.

Testing procedure:

Margin adaptation testing procedure:

Measurements of the cervical vertical marginal gap were conducted following the cementation process. For each specimen, four equidistant markings were made on each surface (mesial, distal, labial, and lingual) at a distance of 1 mm below the margin, utilizing a size 1/2 mm round bur under a stereomicroscope (MA 100 Nikon, Japan) to ensure consistent measurement at the same locations. Four stereo-micrographs were taken for each tooth at a magnification of 100X. All images were subsequently transferred to a computer system for further analysis. Using image analysis software (Omnimet, Buehler, USA), the vertical gaps between the cervical margin of the restorations and the outer edge of the tooth margin were measured at the four equidistant points on each tooth surface, resulting in a total of fourteen data points collected for each tooth.

Elemental analysis:

The specimens underwent comprehensive analysis using environmental energy dispersive X-ray spectroscopy (EDX) with the Quanta 650 system, which utilized a backscattered electron detector (BSED) to assess the surface characteristics of the samples. The integration of scanning electron microscopy (SEM) and X-ray analysis through energy-dispersive X-ray spectroscopy (EDS) offers a robust method for conducting localized microchemical analysis.

Samples immersion in different storage media

The solutions selected for immersion was acidic media and artificial saliva. The samples groups (Ap1 and Bp1) were soaked in artificial saliva at pH 6.8 and placed in incubator at 37°C for 7 days. and the solutions were changed daily. The samples group (Ap2 and Bap2) were soaked in acidic media at pH4.0 and placed in incubator at 37°C for 7 days. and the solutions were changed daily.

Statistical analysis:

The mean and standard deviation values were determined for every group in each test. The data were assessed for normality through the Kolmogorov-Smirnov and Shapiro-Wilk tests, which indicated a parametric (normal) distribution. An independent sample t-test was employed to compare the two groups in unrelated samples. The significance level was set at $P \leq 0.05$. Statistical analysis was performed utilizing IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

Marginal adaptation results:

This table compares marginal gap of TESSRA and PEEK in artificial saliva and acidic media. For TESSRA, there were no significant changes in marginal adaptation in artificial saliva (p=0.489), but a significant change was observed in acidic media (p=0.018). Similarly for PEEK, no significant change was seen in artificial saliva (p=0.506), but a significant change occurred in acidic media (p=0.012). The marginal adaptation values and ranges differ between TESSRA and PEEK, suggesting material-specific responses.

TABLE (1) Comparison of marginal gap between before and after immersion and between artificial saliva and acidic media in TESSRA and PEEK

Material		**Marginal adaptation**	**Artificial saliva**	**Acidic media**	**P value**
			N=6	**N=6**	
TESSRA	*Before immersion*	*Range*	(66.35-74.5)	(65.34-76.42)	0.961
		Mean ± SD	70.28±3.29	70.17±4.02	
	After immersion	*Range*	(67.33-77.46)	(69.43-76.27)	0.207
		Mean ± SD	71.29±3.87	73.86±2.58	
	P value (before vs after)		0.489	0.018*	
PEEK	*Before immersion*	*Range*	(36.66-44.95)	(36.70-43.12)	0.793
		Mean ± SD	40.76±3.49	40.30±2.41	
	After immersion	*Range*	(36.69-46.77)	(42.39-49.19)	0.079
		Mean ± SD	42.57±3.78	46.16±2.43	
	P value (before vs after)		0.506	0.012*	

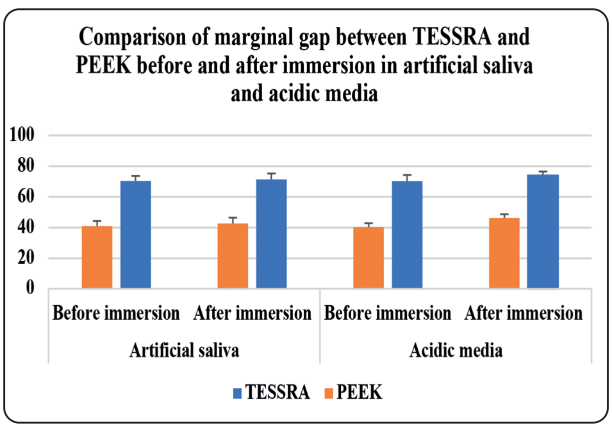
Independent Sampe T test for normally distributed quantitative data between the two groups
Paired Samples T test for normally distributed quantitative data between the two times
****: Significant level at P value < 0.05***

TABLE (1) Comparison of elemental analysis before and after immersion in artificial saliva and acidic media in TESSRA

		Before immersion in artificial saliva	After immersion in artificial saliva	P value	Before immersion in acidic media	After immersion in acidic media	P value
		N=6	N=6		N=6	N=6	
CK	Median IQR	0.04 (0.01-0.04)	0.04 (0.01-0.04)	1	3.25 (1.14-5.2)	9.02 (7.91-9.89)	0.046*
OK	Median IQR	49.28 (47.04-50.82)	49.28 (47.04-50.82)	1	49.85 (47.63-50.84)	43.34 (40.09-46.03)	0.028*
NaK	Median IQR	3.12 (1.88-4.55)	3.12 (1.88-4.55)	1	1.36 (1.13-1.58)	1.58 (1.3-1.88)	0.249
Mg K	Median IQR	0 (0-0)	0 (0-0)	1	0 (0-0)	0.01 (0-0.71)	0.066
ALK	Median IQR	3.36 (3.22-6.11)	3.36 (3.22-6.11)	1	3.29 (3.15-4.46)	2.7 (2.65-2.73)	0.028*
SiK	Median IQR	32.01 (30.64-33.25)	32.01 (30.64-33.25)	1	30.97 (29.38-32.43)	30.97 (28.44-31.93)	0.528
KK	Median IQR	5.84 (1.13-5.94)	5.84 (1.13-5.94)	1	1.71 (1.25-1.9)	1.61 (1.53-1.7)	0.917
CaK	Median IQR	1.3 (1.26-1.36)	1.3 (1.26-1.36)	1	1.12 (0.48-1.35)	1.7 (0.55-2.87)	0.248
PtL	Median IQR	1.48 (0.73-1.91)	1.48 (0.73-1.91)	1	1.71 (1.24-1.9)	1.35 (1.22-1.6)	0.249

Wilcoxon Signed rank test for not normally distributed quantitative data between the two times

Significant level at P value < 0.05



Fig, (2) Comparison of marginal gap between TESSRA and PEEK before and after immersion in artificial saliva and acidic media

Elemental analysis results

This table presents elemental analysis of TESSRA before and after immersion in artificial saliva and acidic media the analysis involves 6 samples for each measurement. Notably, all elemental measurements (CK, OK, NaK, Mg K, ALK, SiK, KK, CaK, and PtL) show no statistically significant changes, with a consistent p-value of 1.0 across all elements. This suggests that immersion in artificial saliva does not cause any significant alterations in the elemental composition of TESSRA material and reveals several statistically significant changes in TESSRA's elemental composition after acidic media immersion. Significant changes (p-value <0.05) were observed in three elements: CK increased from a median of 3.25 to 9.02 (p=0.046), OK decreased from 49.85 to 43.34 (p=0.028), and ALK decreased from 3.29 to 2.7 (p=0.028). Other elements showed no statistically significant changes, suggesting selective elemental alterations under acidic conditions.

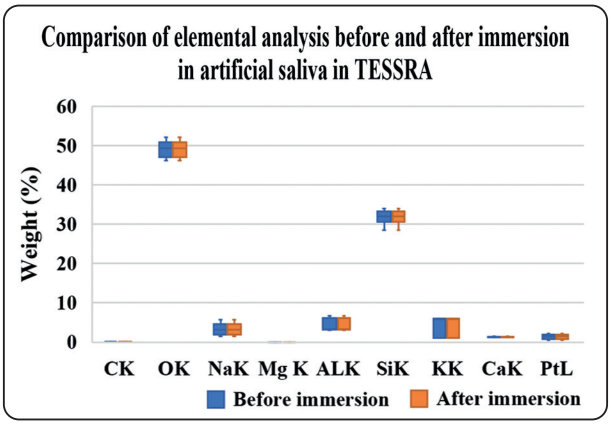


Fig. (3) Comparison of elemental analysis before and after immersion in artificial saliva in TESSRA

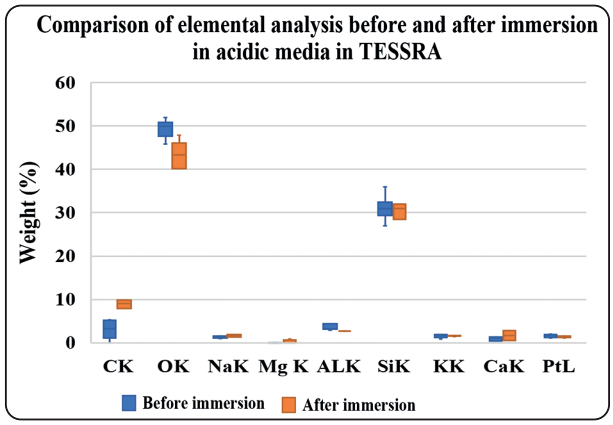


Fig. (4) Comparison of elemental analysis before and after immersion in acidic media in TESSRA

TABLE (3) Comparison of elemental analysis before and after immersion in artificial saliva and in acidic media in PEEK

		Before immersion in artificial saliva	After immersion in artificial saliva	P value	Before immersion in acidic media	After immersion in acidic media	P value
		N=6	N=6		N=6	N=6	
CK	Median IQR	7.09 (5.69-20.35)	7.09 (5.69-20.35)	1	16.04 (11.46-19.27)	16.78 (2.15-25.12)	0.917
OK	Median IQR	46.59 (44.23-49.84)	46.59 (44.23-49.84)	1	45.64 (43.42-47.69)	39.03 (26.54-42.05)	0.028*
NaK	Median IQR	0.38 (0.04-0.62)	0.38 (0.04-0.62)	1	0.02 (0.01-0.39)	0.77 (0.02-2.06)	0.046*
Mg K	Median IQR	0 (0-0.1)	0 (0-0.1)	1	0 (0-0)	0.75 (0.52-0.92)	0.028*
ALK	Median IQR	5.12 (2.4-6.08)	5.12 (2.4-6.08)	1	2.9 (2.61-4.05)	2.66 (1.63-4.66)	0.753
SiK	Median IQR	9.50 (2.36-10.58)	9.5 (2.36-10.58)	1	3.53 (2.79-6.57)	3.80 (0.93-13.88)	0.753
KK	Median IQR	0.35 (0.32-0.56)	0.35 (0.32-0.56)	1	0.4 (0.38-0.41)	0.68 (0.45-0.85)	0.028*
CaK	Median IQR	0.78 (0.36-0.82)	0.78 (0.36-0.82)	1	0.77 (0.62-1.23)	0.82 (0.35-1.17)	0.674
PtL	Median IQR	1.65 (1.20-2)	1.65 (1.20-2)	1	1.39 (1.16-1.69)	1.97 (1.69-2.83)	0.028*

Wilcoxon Signed rank test for not normally distributed quantitative data between the two times

Significant level at P value < 0.05

This table examines PEEK's elemental analysis before and after artificial saliva immersion. The results are consistent across all elements, with a uniform p-value of 1.0 for each measurement. This indicates that artificial saliva immersion does not induce any statistically significant changes in the elemental composition of PEEK material.

Acidic media immersion led to statistically significant alterations in various elements for PEEK. Specifically, the concentration of OK decreased from 45.64 to 39.03 (p=0.028), while NaK rose from 0.02 to 0.77 (p=0.046). Additionally, Mg K increased from 0 to 0.75 (p=0.028), KK rose from 0.4 to 0.68 (p=0.028), and PtL increased from 1.39 to 1.97 (p=0.028). These findings suggest considerable modifications in the elemental composition of PEEK when subjected to acidic environments.

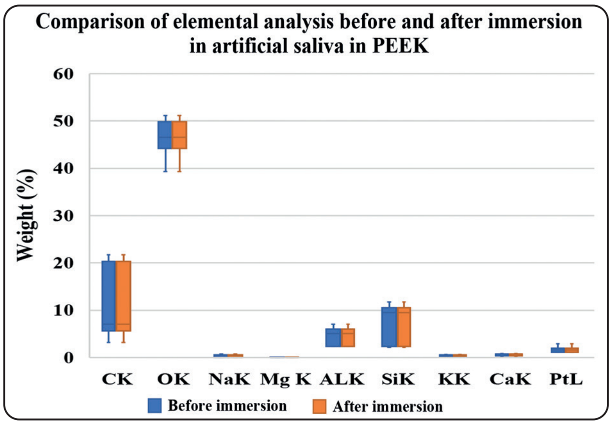


Fig. (5) Comparison of elemental analysis before and after immersion in artificial saliva in PEEK

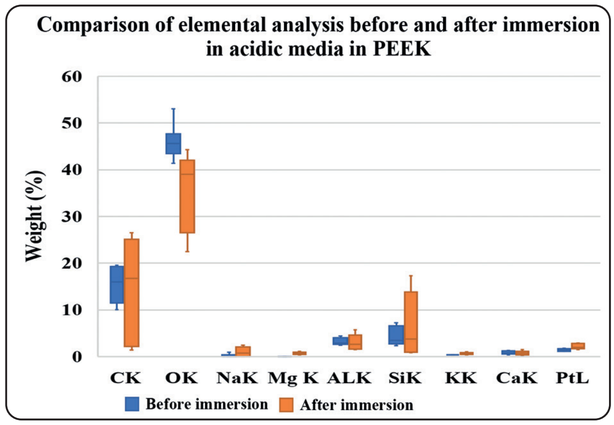


Fig. (6) Comparison of elemental analysis before and after immersion in acidic media in PEEK

DISCUSSION

To enhance restorations' durability, it is crucial to obtain restorations with ideal marginal fit for best prognosis, otherwise microleakage, cement dissolution, recurrent caries, plaque deposition, discoloration & consequently restoration failure might result. [4]

Marginal fit, variation, and adaptation, irrespective of the restoration type, are essential for the durability of dental restorations. [12] In order to obtain pertinent findings for gap analysis, it is crucial to evaluate the fewest gap measurements on the margins of individual crowns using marginal adaptation of fixed prosthodontics. Various techniques have been employed to evaluate marginal adaptation, including direct microscopy, cross-sectional imaging, light-bodied impression replicas, laser videography utilizing light-bodied impression replicas, profilometry, and radiographic microtomography. These methodologies have facilitated both two-dimensional and three-dimensional imaging of the gap between the tooth or model die and the restoration. [13]

Over the years, porcelain veneers have gained popularity as a restorative alternative and have developed into a widely acknowledged procedure that can be created in a number of ways. In modern dentistry, onlays are another popular treatment method for replacing outdated restorations and restoring extensive regions of damage. Modern high-strength materials like lithium disilicate and processing techniques like heat pressing and CAD/CAM have made it possible for dentists to create extremely strong, aesthetically pleasing restorations that can withstand posterior occlusal forces and blend in perfectly with the natural dentition. As a result, new techniques for providing minimally invasive dentistry have emerged. One such method is a combined restoration that the authors refer to as a "vonlay," which can be utilized to repair damaged posterior teeth in place of covering crowns, as this case study illustrates. [14]

Advanced forms of lithium disilicate ceramics, including the variant that incorporates virgilite (Cerec Tessera; Dentsply Sirona), have been created for chairside computer-aided design and computer-aided manufacturing (CAD-CAM) systems to enhance both their mechanical and aesthetic characteristics. [15]

In 2021, Dentsply Sirona launched ALD into the market under the brand name Tessera. This material has been specifically formulated for applications in full-coverage crowns, inlays/onlays, and laminates, comprising 90% LDS crystals and 5% virgilite by volume. CEREC Tessera utilizes two primary crystals in its blocks: virgilite crystal (Li0.5

Al0.5 Si2.5 O6), a variant of lithium aluminum silicate, and LDS (Li2 Si2 O5). According to the manufacturer, ALD offers several advantages, such as rapid crystallization, which takes only four and a half minutes, thus improving production efficiency. Additionally, it allows for faster glaze firing while providing outstanding aesthetics and flexural strength. These advantages stem from a distinctive chemistry that combines two complementary crystal structures within a glassy matrix containing zirconia at 700 MPa. [16] , [17] Dental ceramics have been demonstrated in previous studies to degrade upon contact with acidic substances or aqueous solutions. In this context, alkaline ions are preferentially released, exhibiting greater instability in the glassy phase of dental ceramics compared to the crystalline phase. The degradation of ceramics leads to a roughened surface, an increase in plaque accumulation, and wear on both the teeth and opposing materials. Additionally, the heightened roughness of the ceramic surface may compromise the material's integrity, potentially influencing the clinical outcomes of ceramic restorations. [18]

The improvement of materials can result in significant advancements in both dentistry and technology. Modern materials utilized in advanced dental practices must exhibit biocompatibility, low plaque affinity, attractive aesthetics, and properties that closely resemble those of natural dental structures. This aligns with the expectations of discerning patients and facilitates the effective restoration of dental health. Among the latest innovations in dental materials, PEEK stands out due to its distinctive properties and is increasingly employed in prosthodontics.

PEEK's aging under various environmental circumstances has drawn a lot of attention in the literature, and assessments have been made of the changes in its mechanical characteristics and microstructure. Predicting PEEK's long-term performance, in particular, requires an understanding of how it ages in different solvents. Dimensional changes, mechanical property changes, surface degradation, and chemical changes are just a few of the ways that PEEK's qualities might be impacted by solvent exposure. Physical phenomena like solvent molecules penetrating the PEEK matrix and causing swelling and plasticization or chemical phenomena like reactions within the PEEK structure could be the cause of these changes.[19]

Lieberman et al. in vitro research made a comparison of PEEK, polymethyl methacrylate (PMMA), and composite resin indicates that PEEK exhibits the lowest values for solubility and water absorption. Given that PEEK is a relatively novel material in dentistry compared to composites, ceramics, or zirconia, it is essential to investigate and compile its properties. [20]

Our study aimed to investigate the effect of storage acidic media on the marginal adaptation and elemental analysis of PEEK and Cerec Tessera vonlays. In the master die construction, CNC (Computer Numerical Control) milling machine was used to prepare the teethAll preparation guidelines for ceramic vonlay restorations were followed in the preparation of the sample teeth. This process entailed the construction of an occlusal box with a measurement of half the buccal-lingual distance and a depth of 2 mm. Furthermore, a reduction of 2 mm was applied to the occlusal surface of the functional cuspid, with the preparation extending 2 mm in the cervical direction along the lingual surface. To ensure allocation concealment, randomization of the samples was performed, thereby eliminating any prior knowledge of group assignments.[21]

In the optical impression step, The inEos X5 Sirona extraoral scanner was utilized due to its average accuracy of 25 micrometers, with a maximum misfit of 74 micrometers. Subsequently, the dies were treated with Cerec Optispray to improve the precision of the impression. This technique was used by **Emam** and **Al-Aali et al**. [2223]

The milling of CEREC Tessera™ blocks was done used Sirona MC XL milling machine similar to **Kirsch et al**. The preparation margin was defined on the digital master models, with the cement space calibrated to 60 micrometers. Furthermore, the restoration dimensions were specified within the design parameters to modify the fissure depth, cusp heights, as well as the buccolingual and mesiodistal dimensions, along with the restoration thickness. The central groove was designed with a width of 1.41 mm, a length of 3.69 mm, and a depth of 0.97 mm. This information was subsequently transferred into machine-specific CAM modules, where the necessary instrument geometry and milling strategy were customized to meet the requirements of the milling machine.[24]

In addition, the breCAM.BioHPP bredent disk The components were produced using a 5-axis milling machine (inLab MC X5, Dentsply Sirona), which employs tools of varying geometries with a single motor spindle that moves the restoration along the z-axis. In contrast, 3- or 4-axis milling machines utilize two spindles that grind the restoration from both sides in a U-shaped motion. It has been noted that 5-axis milling machines offer greater accuracy and more efficient milling of surfaces that are near the insertion axis. This machine was also used by **AA Ahmed et al.,** and **Al Hamad et al**.[25 26]

After teeth treatment and bonding procedure, similar to **Nassar, Osama, and El-Mal**, adhesive cement were applied and seated its corresponding die then restorations were placed in a special loading device under 5kg load, and polymerization was then initiated using a light cure for two seconds to allow removal of excess cement completely using a sharp explorer then a layer of layer of Panavia oxy-guard was applied around the margins of the vonlay to allow complete polymerization of resin during curing.[27]

In our study, like **Ellakany et al.** the samples were subjected to 5000 thermal cycles using a thermocycling machine. These cycles involved temperature variations ranging from 5 °C to 55 °C, with each temperature maintained for 30 seconds in a water bath, followed by a 10-second transition period between the different temperature baths. This process accurately simulated the temperature fluctuations experienced in the oral cavity.[28]

The study specimens were soaked in a media where (Ap1 and Bp1) were soaked in artificial saliva at pH 6.8 and placed in incubator at 37°C for 7 days and (Ap2 and Bap2) were soaked in acidic media at pH4.0 and placed in incubator at 37°C for 7 days. In the analytical process, measurements were taken of the vertical gaps between the cervical margin of the restorations and the outer edge of the tooth margin at four equidistant locations on each tooth surface, resulting in a total of fourteen data points collected for each tooth. The elemental analysis was performed using an environmental EDX (The energy dispersive X-ray spectroscopy (Quanta 650), employing a backscattered electron detector (BSED) to characterize the surface of the samples and SEM similarly reported by **Dias et al.** study. [29] This approach was employed because it facilitated sophisticated experimental inquiries, which, in conjunction with reliable data acquisition techniques and analysis, enable a comprehensive evaluation of the system being investigated. Beyond morphological and structural evaluations, microscopic techniques provide additional understanding of both the quantitative and qualitative chemical composition of the sample under examination, whether at a particular site or along a specified trajectory. This results in the generation of elemental maps (Energy Dispersive X-ray Spectroscopy—EDS), crystal orientation data (Electron Backscatter Diffraction—EBSD), and various other characteristics of dental biomaterials. [30]

The findings of our study indicated statistically significant differences. ($p<0.001^*$), indicating substantial variations in marginal gap between the two materials across both artificial saliva and acidic media conditions. Before immersion in artificial saliva, Tessera marginal gab was reported (66.35-74.5) 70.28±3.29, while after immersion it was reported (67.33-77.46) 71.29±3.87. On the other hand, PEEK marginal gab showed a (36.66-44.95)

40.76±3.49before immersion artificial saliva. After immersion, it reported a (36.69-46.77) 42.57±3.78.

As for the acidic medium, Tessera reported (65.34-76.42) 70.17±4.02 before immersion, while it reported (69.43-76.27) 73.86±2.58 after immersion. Conversely, PEEK showed a marginal gap of (36.70-43.12) -(40.30±2.41) before immersion, whilst it reported (42.39-49.19) 46.16±2.43 after immersion. Our study revealed that PEEK consistently compromised higher marginal adaptation values compared to TESSRA, both before and after immersion.

Two mechanisms could account for these findings. It begins with the disintegration of the ceramic's silicate network (Si-O-Si) and the leaching of alkali ions from the ceramic surface as a result of hydrogen ions from the aqueous environment penetrating the ceramic. Alkali metal ions will often leach more quickly in the glass phase because they are less stable there than in the crystalline phase.24 Porosities in the glass matrix may result from the release of silicone ions as well as other ions like potassium and sodium from the ceramic's surface.[31] And these results are in accordance with elemental analysis results of our study·

Another explanation for our results is Water and acid molecules find it difficult to diffuse through PEEK because to its dense molecular packing. Furthermore, PEEK's molecular chains are extremely stable and show little movement even at high temperatures because to its high glass transition temperature. Water transport through PEEK is thus impeded by its poor molecular mobility and tight molecular packing. Furthermore, because of the low concentration of acid that diffuses through the sample surface, the thicker samples had a lower maximum mass uptake because the acid was harder to diffuse in the bulk material (below the surface). Furthermore, the formation of new, well-arranged chains in the microstructure as a result of the surface's increasing crystallinity with age hinders the diffusion of acid in the thick PEEK film's succeeding layers. [32]

Our results came in accordance with a previous study conducted by **Chouksey et al.** who compared the marginal fit of PEEK and zirconia copings using a field emission scanning electron microscope (FESEM) in order to assess their clinical applicability. They concluded that PEEK copings showed greater marginal adaptability with a mean marginal gap value of 33.99 ± 8.81 μm compared to zirconia copings which showed higher discrepancy, with a mean marginal gap of 56.21 ± 15.07 μm.[33]

Conversely, our results do not align with **Godil et al.** who investigated the marginal and internal fit of endocrowns using lithium disilicate and PEEK fabricated by computer -aided manufacturing (CAD-CAM). The findings indicated that CAD-CAM endocrowns made from lithium disilicate exhibit superior marginal and internal fit in comparison to PEEK endocrowns. Nevertheless, the marginal gap for both types of CAD-CAM materials remained within the clinically acceptable threshold of ≤120 µm. [34]

In addition, our results were indifferent with **Jayesh et al.,** who compared the The study examined the marginal fit and fracture resistance of PEEK material in comparison to two other restorative crowns produced through CAD-CAM technology. The results indicated that the marginal fit of all ceramic-zirconia crowns surpassed that of both the PEEK and DMLS-metal ceramic crowns. [35]Also, **Katamish at al**., study findings revealed that who reported that vertical marginal gaps were greater in a sample of PEEK veneers compared to zirconia. [36]

It is noteworthy that every marginal gap evaluated in this investigation was below the 120 μm clinically acceptable limit. However, according to other research, typical crowns can be placed between 160 and 172 μm. For every tested group in our investigation, the recorded marginal gap values fell short of the highest clinically acceptable levels found in the literature. [3738]

The null hypothesis of this study is that there would be no difference in the marginal gap of PEEK or Tessera vonlays when immersed in different storage media. So, after testing procedures the null hypothesis was accepted.

CONCLUSIONS

Based on the constraints of the current research, the following conclusions can be drawn.

- PEEK demonstrates better marginal adaptation compared to TESSERA.
- A statistically significant difference was found between PEEK and TESSERA, showing substantial variations in marginal adaptation for both materials under both artificial saliva and acidic media conditions.
- Neither PEEK nor TESSERA showed significant changes in their elemental composition after immersion in artificial saliva.
- PEEK and TESSERA exhibited substantial modifications in the elemental composition of several elements when immersed in acidic media.

RECOMMENDATIONS

Further studies should be done with different torage media to set up guidelines for marginal adaptation

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