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EFFECT OF STORAGE MEDIA ON THE RETENTION OF PEEK AND TESSERA VONLAYS

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ABSTRACT

Introduction: the long-term success of indirect restorations such as vonlays depends significantly on their retention, which may be influenced by the restorative material and the oral environment. Polyetheretherketone (PEEK) and TESSERA, an advanced hybrid ceramic, are emerging materials in indirect restorations. Understanding how storage media simulating oral conditions affect their retention is essential for clinical predictability.

Objectives: The aim of this study is to evaluate the effect of storage media on the retention of PEEK and TESSERA vonlays.

Materials and methods: A total of 36 vonlay samples were prepared and divided into two main equal groups. Group A was fabricated of CEREC Tessera™ blocks, while Group B (was constructed using breCAM.BioHPP bredent milling disk. Each group was further split into three subgroups based on the type of storage medium: one subgroup P1: vonlay samples control group ,(P2) was immersed in an acidic solution, and the last subgroup (P3) was stored in artificial saliva. The samples were subjected to thermal aging. The Retention was measured after cementation using a universal testing machine.

Results: TESSERA vonlays revealed statistically significant higher retention compared with the PEEK vonlays before immersion and after immersion in acid and saliva.

Conclusion: Vonlays are a conservative and biologically compatible option for restoring endodontically treated premolars. PEEK and TESSERA showed significant differences in retention, indicating material-specific performance under different storage media.

KEYWORDS: Retention– Storage media –PEEK –Vonlays –TESSERA

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INTRODUCTION

Tissue preservation serves as a fundamental principle in modern dentistry. One such innovative approach is the vonlay—a hybrid restoration that combines the features of an onlay with an extended buccal veneer. Designed for use in the premolar region, the vonlay offers a conservative substitute for full-coverage crowns. For long-term clinical success, achieving an optimal retention is essential. Inadequate retention can lead to complications ultimately compromising the restoration's longevity.

In the past decade, there has been a significant rise in the development of new restorative materials, driven by the growing demand for improved dental aesthetics and restorative outcomes.(1) Moreover, the integration of advanced manufacturing technologies, such as computer-aided design and computer-aided manufacturing (CAD/CAM), has emerged as a highly efficient alternative to traditional, time-intensive fabrication techniques—reducing production time by as much as 90%.(2-4) This rapid evolution highlights the need for a comprehensive evaluation of the diverse materials utilized in CAD/CAM systems.

PEEK is a high-temperature, semi-crystalline synthetic thermoplastic polymer that is considered highly suitable for use in dental applications.(5) PEEK recognized for its favorable mechanical, chemical, and physical characteristics, making it a valuable material in dentistry. PEEK has excellent biocompatibility, high resistance to heat, superior fatigue resistance, notable toughness, low wear rate, and strong resistance to corrosion and aging. It is also appreciated for its ease of fabrication and color stability.(6) It has been suggested for use in various fixed and removable prosthetic applications fabricated through CAD-CAM technology. PEEK has also been recommended for specific clinical uses such as intra-radicular posts, occlusal splints, custom healing abutments, implant abutments, and provisional restorations. Despite its potential, the number of available clinical studies assessing its performance remains limited.(7,8)

CEREC Tessera (Dentsply Sirona), is an "advanced" lithium disilicate ceramic.(9) CEREC Tessera have been launched in 2021 by Dentsply Sirona, is a CAD/CAM ceramic material engineered to improve both the aesthetic outcome and clinical efficiency of prosthodontic treatments, and was introduced for use with chairside CAD-CAM systems, aiming to enhance both aesthetic and mechanical performance.(9)

CEREC Tessera is a glass-ceramic material composed of lithium disilicate and virgilite crystals embedded in a zirconia-reinforced matrix. The fine, needle-like crystals enhance the material's strength by increasing density and resisting crack propagation. Virgilite also contributes to the material's optical and aesthetic properties, making CEREC Tessera a strong and highly esthetic ceramic option.(10) Its quick processing time helps minimize chairside duration, offering advantages for both dental professionals and patients. The material is suitable for a variety of restorative applications, including crowns, inlays, onlays, and veneers in both the anterior and posterior areas.(9) According to the company, the material contains rod-shaped crystals that function similarly. Dental ceramics are widely regarded as chemically inert restorative materials; however, their long-term durability can be influenced by several factors. These include the material's composition, microstructure, and chemical properties, as well as environmental factors such as exposure to acidic or erosive agents, the duration of exposure, and temperature variations.(11)

This study specifically concentrates on two promising materials, which are widely used due to their versatility, favorable mechanical and biological behavior. These materials can be quickly processed for various applications; however, their retention properties may be significantly influenced by exposure to the oral environment with exposure to saliva, acidic or erosive agents, the duration of exposure, and temperature variations as in case in ceramics.[11] Moreover, The constant exposure of these materials to saliva and different pH highlights the importance of assessing their influences on the mechanical of these materials.

Therefore, the objective of this study was to investigate the impact of different storage media on the retention of PEEK and TESSERA vonlays.

The null hypothesis of this study proposed that there would be no significant difference in the retention of PEEK and TESSERA vonlays when exposed to different storage.

MATERIALS AND METHODS

Sample Size Calculation

The minimal sample size is calculated based on a previous study aimed to assess the retention strength of Resin Nano Ceramics and Polyetheretherketone after different surface treatments.[1]

El-Tahwi et al. (2019)[12] concluded that airborne-particle abrasion with 50 µm alumina before cementation enhances retention strength of both RNC and PEEK crowns. Adhesive failure mode at the cement-dentin interphase and cohesive within the ceramic material denoted adequate bonding between the tested materials and luting agent. Based on El-Tahwi et al. (2019)[12] results, and adopting a power of 80% (b=0.20) to detect a standardized effect size in the retention (primary outcome) of 0.721, and level of significance 5% (α error accepted =0.05), the minimum required sample size was found to 18 specimens per group (number of subgroups=3) (Total sample size=36 specimens).[13] Any specimen loss from the study sample due to processing error will be replaced to maintain the sample size.[14]

- ***Software***

The sample size was calculated using GPower version 3.1.9.2 [15].

Sample Grouping

A total number of 36 samples were constructed and classified into two groups according to the materials used:

- Group A: vonlay samples (n=18) were fabricated of CEREC Tessera™ blocks
- Group B: vonlay samples (n=18) were fabricated of breCAM.BioHPP Bredent milling disk
- Each group was subdivided into three subgroups:

o P1: vonlay samples (n=6) control group

o P2: vonlay samples (n=6) immersed in acidic media.

o P3: vonlay samples (n=6) immersed in artificial saliva.

Natural teeth selection and preparation

Natural tooth selection

Natural teeth were freshly extracted with comparable configuration representing upper first premolar was selected. The remaining soft tissue was removed by ultrasonic scaler[16] and the teeth were disinfected. These teeth were extracted due to orthodontic cause.

Inclusion criteria: Extracted human maxillary premolar free of dental caries or restoration.

Exclusion criteria

- Teeth with fractured roots
- Teeth with lesions or fractured extending to apical to the cement-enamel junction
- Teeth with visible cracks
- Endodontically treated teeth
- Teeth with internal or external resorption

Natural tooth preparation

- For standardization of preparation, CNC (C..N.C Premium Imes. ICore. Germany) (Computer

Numerical Control) milling machine was used to prepare the teeth. The tooth was prepared following standard dimensions for all-ceramic vonlay restoration guidelines. An occlusal box was designed to cover half of the buccolingual width, with a depth of 2 mm. A 2 mm occlusal reduction was carried out on the functional cusp, and the preparation was extended 2 mm cervically on the lingual surface. All procedures were performed using CNC technology. Additionally, the preparation design included a buccal veneer extension toward the labial surface, with a 0.5 mm chamfer reduction.(17)

Prior to preparation putty index was done using (panasil putty material) (Biochemazone, KETTENBACH GmbH and Co. KG, Eschenburg, German) addition silicon material to guide and judge the preparation. After reducing the facial surface, the proximal and occlusal surfaces were also prepared, ensuring that all line angles and gingival margins were smoothly rounded and finished. A Jota Arkansas stone was then used to achieve a perfectly smooth surface.649 (Jota Dentistry, Swiss) was used. **Figure (1)**

Optical impression of the teeth:

The prepared teeth were digitized using the inEos X5 Sirona extraoral scanner (Dentsply Sirona, Milford, USA). To improve scanning accuracy, the teeth were coated with CEREC Optispray (Dentsply Sirona, Milford, USA), which minimized optical reflections and provided a consistent reflective surface. The accuracy of the scan was verified to confirm that a complete and defect-free digital model of the tooth was successfully captured.

Computer aided restoration designing:

The margins of the digital die were delineated using Sirona inLab CAD Software (Dentsply Sirona, Milford, USA). Following this, the path of insertion was established to initiate the restoration design. The appropriate milling materials were selected from the software's library. A cement space of 60 micrometers was set, and the restoration dimensions were defined in the design interface. Adjustments were made to fissure depth, cusp heights, and the buccolingual and mesiodistal dimensions, as well as the overall thickness of the restoration. The central groove was modified to have a width of 1.41 mm, a length of 3.69 mm, and a depth of 0.97 mm..

Milling was accomplished using: Sirona MC X5 (Dentsply Sirona, Milford, USA) to mill breCAM. BioHPP bredent disk. Sirona MC XL (Dentsply Sirona, Milford, USA) milling machine using CEREC Tessera™ blocks.

EIGHTEEN **CEREC Tessera™ blocks** with block size C14 shade A2 HT were used. Each block was inserted into the work piece spindle and

Fig. (1) : Natural tooth vonlay preparation tightened, 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 process was completed, each vonlay was carefully examined for any defects. They were then separated from the blocks with caution and fitted onto the corresponding dies to assess marginal accuracy. Any discrepancies were identified using a sharp probe under 3.5× magnifying loupes.. The thickness of the restoration was subsequently measured with a conventional caliper. (Generic, Pakistan) to ensure that the preset thickness was maintained.

- **Bonding procedure:**
- ***Vonlay surface treatment:***

The intaglio surface treatment of all vonlays was carried out following the manufacturer's guidelines, which were identical for both restoration groups.

For the TESSERA vonlays, the internal surface was treated with 9.5% hydrofluoric acid gel (Bisco, Inc., USA) using a mini sponge for 20 seconds, then thoroughly rinsed with a strong stream of water for an additional 20 seconds. A single layer of silane coupling agent (Porcelain Primer, Bisco, USA) was applied using a mini brush, left to react for 30 seconds, and subsequently dried with an oil-free air spray. In contrast, the PEEK vonlays were treated by first sandblasting the internal surface, then applying Visio.link primer (Bredent, Germany) to enhance bonding.

- ***Tooth surface treatment***

To condition the tooth surfaces, a 37% phosphoric acid etchant gel (Meta Etchant, Metabiomed, Korea) was applied for 30 seconds, followed by thorough rinsing and drying with air. A light-cured adhesive bonding agent (All-Bond Universal, BISCO Inc, USA) was applied using a micro-brush, left untouched for 30 seconds, gently air-thinned, and then cured for 20 seconds using a light-curing unit (iLEDd Woodpecker, China). For the cementation, a dual-cure self-adhesive resin cement (Breeze, Pentron, USA) was used. The cement was dispensed through auto-mixing tips per manufacturer guidelines and applied to the intaglio surface of each vonlay, covering the axial walls. Each restoration was then seated on its corresponding die, and a standardized load of 5 kg (50 N) was applied to the occlusal surface using a custom-designed cementation device.

Cementation loading procedure:

To ensure uniform load application during the cementation of each vonlay, a specially designed loading device was used. This apparatus A custom loading device was used to standardize pressure during vonlay cementation. It consisted of two horizontal plates and a vertical steel rod to apply weight. Each vonlay was placed on a resin die, and a 2 kg static load was applied for five minutes using the device.

Polymerization was initiated with a brief two-second light cure to facilitate the removal of excess cement from the restoration margins using a sharp explorer. Subsequently, a layer of Panavia Oxyguard was applied around the vonlay margins to ensure complete polymerization of the resin during curing. Each surface was then light cured for 30 seconds using a blue halogen curing unit (iLED Woodpecker, China) with an intensity of 3200 mW/cm^2.

Thermal aging:

Thermocycling was performed using a custom-made device containing four tanks filled with deionized water maintained at specific temperatures.

All specimens underwent 5000 thermocycles, simulating roughly six months of intraoral service. Each cycle involved immersing the samples for 15 seconds in each tank, following this sequence: 5 °C, 37 °C, 55 °C, and then back to 37 °C, in accordance with ISO 11405 guidelines.

Testing procedure

Pull Off Test:

An upper holding device was designed to secure the vonlays, and the specimens were mounted in a universal testing machine. Vertical alignment during load application was achieved using a toroid fixation located at the upper part of the embedding mold. A specially fabricated chain with a locking mechanism was used to ensure uniform distribution of the applied tensile forces. The cemented vonlays were pulled off along their path of insertion at a crosshead speed of 0.5 mm/min until separation occurred and debonding was observed. Some specimens experienced fracture during the testing process. The force needed to dislodge each vonlay was recorded in Newtons (N). For fractured specimens that failed prior to testing, the tensile strength was recorded as 0 MPa. The bond strength values (in MPa) were then determined by dividing the dislodgment force by the bonding area, measured using the Cerec Volume Program (Sirona).

Samples immersion in different storage media

immersion solutions used in this study were artificial saliva and an acidic medium. Groups Ap3 and Bp3 were immersed in artificial saliva (pH 6.8) and incubated at 37°C for a period of 7 days, with the solution being refreshed daily. In parallel, groups Ap2 and Bp2 were immersed in an acidic solution (pH 4.0) under the same incubation conditions, with daily replacement of the medium.

Statistical analysis:

The mean and standard deviation were determined for each group across all tests. The normality of the data was assessed using both the Kolmogorov-Smirnov and Shapiro-Wilk tests, which confirmed a normal (parametric) distribution.. To compare independent groups, an independent samples t-test was conducted. A significance level of $P \leq 0.05$ was considered statistically significant. All statistical analyses were carried out using IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

(data are presented as mean ± SD)

The Retention (N):

The retention (before) was statistically significantly higher in the Tessera Group compared with the PEEK Group (p<.001)

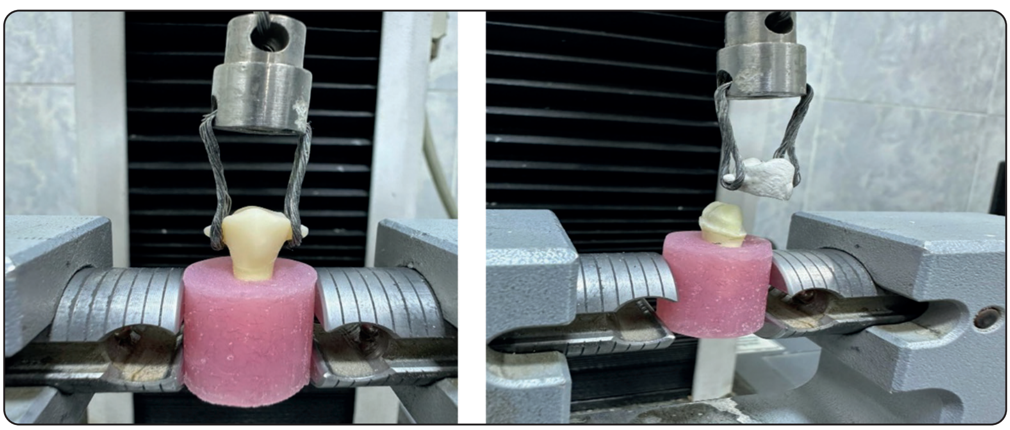

Fig. (2) Pull Off Test

TABLE (1) Retention (N) (P1) in the two studied groups

Retention (N) Before	**Group**		**Independent t-test *p*-value**
	PEEK (n=6)	**Tessera** (n=6)	
- Min. – Max.	201.761-250.691	408.141-520.276	
- Mean ± Std. Deviation	230.480±17.724	465.991±41.417	$t_{(df=10)}$=12.805
- 95% CI of the Mean	211.879-249.080	422.527-509.456	*p*<.001*

n: Number of patients ***Min-Max: Minimum – Maximum*** ***S.D.: Standard Deviation***

CI: Confidence interval ***df=degree of freedom*** ****: Statis***

The retention (After Acid) was statistically significantly higher in the Tessera Group compared with the PEEK Group (*p*<.001)

TABLE (2) Retention (N) (P2) in the two studied groups

Retention (N) After acid	**Group**		**Independent t-test *p*-value**
	PEEK (n=6)	**Tessera** (n=6)	
- Min. – Max.	190.362-245.423	395.802-501.984	
- Mean ± Std. Deviation	222.690±19.489	453.772±39.434	$t_{(df=10)}$=12.868
- 95% CI of the Mean	202.237-243.142	412.388-495.156	*p*<.001*

n: Number of patients ***Min-Max: Minimum – Maximum*** ***S.D.: Standard Deviation***

CI: Confidence interval ***df=degree of freedom*** ****: Statistically significant (p<.05)***

The retention (After saliva) was statistically significantly higher in the Tessera Group compared with the PEEK Group (*p*<.001)

TABLE (3) Retention (N) (P3) in the two studied

Retention (N) After Saliva	**Group**		**Independent t-test *p*-value**
	PEEK (n=6)	**Tessera** (n=6)	
- Min. – Max.	195.917-248.093	407.769-508.976	
- Min. – Max.	226.151±18.751	460.959±37.890	$t_{(df=10)}$=13.605
- Mean ± Std. Deviation	206.474-245.829	421.196-500.723	*p*<.001*

n: Number of patients ***Min-Max: Minimum – Maximum*** ***S.D.: Standard Deviation***

CI: Confidence interval ***df=degree of freedom*** ****: Statistically significant (p<.05)***

TABLE (4) Comparison of the retention (N) in the two studied groups

Retention (N)	Group		Independent t-test *p*-value
	PEEK (n=6)	Tessera (n=6)	
Before			
- Min. – Max.	201.761-250.691	408.141±520.276	$t_{(df=10)}$=12.805
- Mean ± Std. Deviation	230.480±17.724	465.991±41.417	$p<.001$*
- 95% CI of the Mean	211.879-249.080	422.527-509.456	
After Acid			
- Min. – Max.	190.362-245.423	395.802-501.984	$t_{(df=10)}$=12.868
- Mean ± Std. Deviation	222.690±19.489	453.772±39.434	$p<.001$*
- 95% CI of the Mean	202.237-243.142	412.388-495.156	
After Saliva			
- Min. – Max.	195.917-248.093	407.769-508.976	$t_{(df=10)}$=13.605
- Min. – Max.	226.151±18.751	460.959±37.890	$p<.001$*
- Mean ± Std. Deviation	206.474-245.829	421.196-500.723	
Test of significance	$F_{(df=2)}$=43.437	$F_{(df=2)}$=31.058	
***p*-value**	$p<.001$*	$p<.001$*	

n: Number of patients ***Min-Max: Minimum – Maximum*** ***S.D.: Standard Deviation***
CI: Confidence interval ***df=degree of freedom*** ****: Statistically significant (p<.05)***

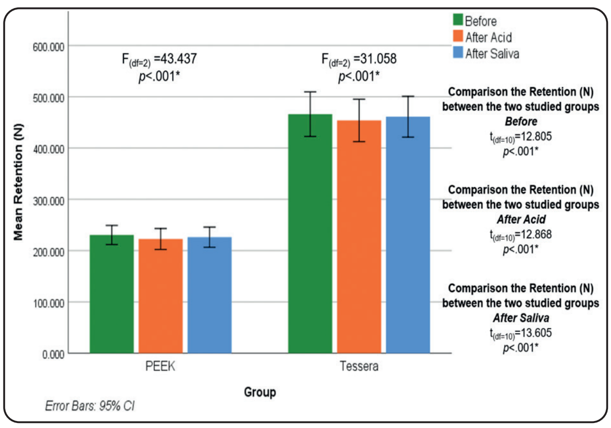

Fig. (2) Cluster bar chart of the he retention (N) in the two studied groups

Comparison of the retention (N)

The **PEEK Group** Intragroup analysis revealed that the retention was statistically significantly decreased after acid and after Saliva compared with before (p=.002 and p=.011, respectively). In addition, the retention was statistically significantly increased after saliva compared with after acid (p=.007).

The **Tessera Group** Intragroup analysis revealed that the retention was statistically significantly decreased after acid compared with before (p=.003). In addition, the retention was statistically significantly increased after saliva compared with after acid (p=.004).

DISCUSSION

The retention of extra-coronal restorations is a critical concern for both clinicians and patients. Vonlays are a recently introduced conservative restoration approach that combines features of both veneers and onlays. Designed as an alternative to full coverage restorations in the posterior region, vonlays cover both the buccal and occlusal surfaces. The buccal coverage serves as a veneer, meeting aesthetic demands while offering partial coverage. Although veneers are rarely used for premolars, this combined design provides both function and esthetics.[18]

Recent advancements in dental materials and computer technology have significantly expanded the use of CAD-CAM-fabricated restorations in clinical practice. These systems allow the creation of restorations from a variety of materials, including ceramics, metal alloys, and different types of composites.[19]

The present study aimed to evaluate the effect of storage media on the retention of PEEK and TESSERA vonlays.

In this study, natural teeth were selected to closely replicate clinical conditions, offering realistic morphology, architecture, and bonding characteristics essential for evaluating adhesive restorations.[20] Given the inherent variability in tooth dimensions, a single maxillary premolar meeting specific inclusion criteria was designated as the master die to ensure consistency and standardization across samples, as recommended by Fernández-Estevan et al. (2017)[20,21] To further enhance the clinical relevance of the experimental setup, periodontal ligament simulation was incorporated using addition silicone, in line with methods described by Soares et al. (2005)[20] and Nawafleh et al. (2020)[23]. This step is considered essential for replicating fracture testing conditions more accurately.

To standardize the preparation process, the protocol followed the guidelines for all-ceramic restorations as outlined by Rocca et al. (2007).[24] A Computer Numerical Control (CNC) milling machine was employed to fabricate the master die, ensuring uniformity across samples. The preparation strictly adhered to established criteria for ceramic vonlay restorations. An occlusal box was designed to measure half the buccolingual width with a depth of 2 mm. Additionally, a 2 mm reduction was performed on the functional cusp's occlusal surface, extending 2 mm cervically along the lingual surface, following the methodology of by Sayed et al. (2022) [25] and Mohammed et al. (2025),[26]

To ensure unbiased results, sample randomization was performed with allocation concealment, thereby eliminating any foreknowledge of group assignments (25). During the optical impression phase, the inEos X5 (Sirona) extraoral scanner was utilized, offering an average scanning accuracy of 25 μm and a maximum misfit of 74 μm (26). To enhance scanning precision, the dies were treated with Cerec Optispray, following the methodology described by Al-Aali et al.[27]

To closely replicate the natural dimensions of a premolar, the restoration design included a minimum occlusal thickness of 2 mm. This approach is supported by Chen et al..[28], who reported that lithium disilicate (E.max) crowns with minimal thickness can be a reliable option when supported by high-elastic-modulus substrates such as enamel.[29] Furthermore, the cement gap was standardized to 60 μm, based on the findings of Kale et al. (2016) [30],, which highlighted the significant impact of cement space on fracture resistance.

The preparation margins were defined on the digital master models, and the design parameters—including fissure depth, cusp height, buccolingual and mesiodistal dimensions, and restoration thickness—were adjusted accordingly. Specifically, the central groove was set to a width of 1.41 mm, a length of 3.69 mm, and a depth of 0.97 mm, consistent with the values reported by Elsayed et al. (2020)[31] This design data was then transferred to the machine-specific CAM modules, where milling strategies and instrument geometries were optimized according to the specifications of the milling machine.[32]

To ensure unbiased results, sample randomization was conducted with allocation concealment, preventing any foreknowledge of group assignments.[33]

In the optical impression step, the inEos X5 Sirona extraoral scanner[29] was employed, offering an average accuracy of 25 micrometers, with a maximum misfit of 74 micrometers. To enhance the precision of the impression, the dies were subsequently treated with Cerec Optispray. This method was also utilized by Al-Aali et al.[27]

The Sirona MC XL milling unit (Dentsply Sirona, Milford, USA) was used with CEREC Tessera™ blocks following a procedure similar to that described by Kirsch et al.[30] In this study, restorations were fabricated using the chairside Sirona MCXL milling machine, which offers a precision of up to 10 μm. As reported by Kirsch et al.[30] the MCXL system enables the production of highly accurate and homogenous restorations. Notably, the extra-fine mode of the 4-axis CEREC MCXL achieved outcomes comparable to those of 5-axis milling systems, while offering the advantage of reduced milling time.

The components fabricated from breCAM. BioHPP (bredent disk) were milled using a 5-axis milling machine (inLab MC X5, Dentsply Sirona), which employs tools of varying geometries operated by a single motor spindle that moves along the z-axis. Unlike 3- or 4-axis milling systems—where two spindles typically perform U-shaped grinding from opposing sides—the 5-axis system offers enhanced precision and more efficient milling, particularly for surfaces aligned with the insertion axis. This advanced milling approach was similarly utilized in studies by Ahmed et al.,[34] and Al Hamad et al. [35].

Surface treatment of the restorations was conducted based on the protocol described by Li et al. (36), aiming to enhance the bond strength between lithium disilicate ceramics and resin-based adhesives. This procedure plays a vital role in improving the adhesion of all-ceramic restorations. Each ceramic restoration was etched with hydrofluoric acid for 20 seconds to develop a micro-retentive surface pattern, then treated with a silane coupling agent. The silanization step promotes chemical bonding by forming a dual-functional interface between the ceramic's silica component and the resin adhesive. The Sirona MC X5 (Dentsply Sirona, Milford, USA) was employed to mill breCAM.BioHPP disks from bredent a procedure similar to that described by Mohammed et al[26]

Upon completion of the milling process, each vonlay was meticulously examined for any flaws, then gently detached from the blocks and placed on the corresponding dies to evaluate marginal fit and detect discrepancies using a sharp explorer and 3.5x magnification loupes. Restoration thickness was verified using a standard caliper to ensure adherence to the predetermined dimensions. All fabricated restorations were subsequently cleaned in an ultrasonic bath filled with 98% alcohol to eliminate residual milling debris, following a procedure comparable to that outlined by Elsayed et al. (2020).[31]

As reported by Stamatacos et al. (2013)[37], cementation was performed using a dual-cure self-adhesive resin cement. This type of cement offers a simplified and efficient bonding process by eliminating the need for traditional multi-step adhesive systems.

Following the methodology of Palacios et al. (2006)[38], a custom-designed loading device was used during cementation to ensure consistent seating of all restorations. This device applied a standardized load of 50 N to each sample. Additionally, in this study, all bonded specimens underwent thermocycling using an automated thermal cycling machine to simulate oral aging conditions.[39]

After the teeth treatment and bonding procedure, similar to the approach used by Nassar, et al.[40] adhesive cement was applied to the restorations, which were then seated on their corresponding die. The restorations were placed in a special loading device under a 5 kg load (50 N), and polymerization was initiated using a light cure for two seconds. This step allowed for the complete removal of excess cement using a sharp explorer. A layer of Panavia

Oxyguard was then applied around the margins of the vonlay to ensure the complete polymerization of the resin during the curing process. The method was used by Mohammed et al. (2025),[26]

Following the method of Ellakany et al.,[41] and Hashem et al. [40]the samples were subjected to 5000 thermal cycles using a thermocycling machine to represent approximately 6 months of clinical use. These cycles involved temperature variations 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 effectively simulated the temperature fluctuations encountered in the oral cavity.[41] 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.[42]

In this study, specimens were immersed in two different storage media to simulate oral conditions. Groups Ap1 and Bp1 were stored in artificial saliva (pH 6.8) at 37°C for 7 days, while groups Ap2 and Bp2 were incubated in an acidic medium (pH 4.0) under the same conditions.

The present study findings revealed that the retention (before, after acid and after saliva) was statistically significantly higher in the Tessera Group compared with the PEEK Group ($p<.001$), indicating notable variations in the retention between the two materials under both artificial saliva and acidic media conditions. However, the study revealed that PEEK and the Tessera Groups showed a decreased retention after acid and after Saliva immersion compared with before.

CEREC Tessera™ blocks, can be etched with hydrofluoric acid, allowing for effective bonding with resin cements. This enables more conservative preparations, such as veneers or onlays, and also enhances retention in cases with short clinical crowns and limited mechanical retention.[9]

According to the manufacturer, Advanced Lithium Disilicate (ALD) consists of lithium disilicate (LDS) and virgilite (lithium aluminum silicate) within a zirconia-enriched glass matrix. During firing, additional virgilite crystals form, contributing to increased pre-compression stress. The rod-like LDS crystals enhance tensile strength and crack resistance, while virgilite and zirconia work synergistically within the glassy matrix. ALD's fine microstructure—featuring LDS crystals (\~0.5 µm) and virgilite (0.2–0.3 µm)—improves both optical properties and mechanical performance (43).[43-45] Bebsh et al. (2021),[46] attributed improved mechanical properties of certain ceramics to the incorporation of 10% zirconia, which serves as a filler material to enhance strength and durability

Riad et al. (2020),[47] study demonstrated that lithium disilicate endocrowns exhibited a significantly higher mean tensile bond strength compared to PEEK endocrowns. This enhanced bonding performance is likely due to the strong chemical affinity between lithium silicate ceramics and resin cements, as supported by previous research[48-50]

In the region of the maxillary premolars, average masticatory forces are approximately 450 N, while occlusal forces during clenching can reach up to 660 N[51]. The current study revealed that the CEREC Tessera tested group retention exceeded typical masticatory force values.

The reduction in retention observed in CEREC Tessera following acidic exposure may be attributed to the degradation of the ceramic's silicate network (Si–O–Si) and the leaching of alkali ions, caused by hydrogen ions penetrating the ceramic surface.[32] . In contrast, the glaze firing process in Advanced Lithium Disilicate (ALD) may repair surface flaws through an auto-glazing effect, where the glassy phase fills surface defects, improving smoothness and mechanical properties.[52]

Elsherbini et al. (2023)[53] demonstrated that acidic challenge significantly increased the surface roughness of both ALDS and ZLSC materials. Their study employed 37% HCl at pH 1.2 for 24 hours, simulating long-term intraoral acidic exposure equivalent to several years.(54) This prolonged exposure led to a more irregular and roughened surface morphology in both ceramics.

An additional explanation for the findings is the limited diffusion of water and acid molecules through PEEK, attributed to its densely packed molecular structure. PEEK's high glass transition temperature results in highly stable molecular chains with minimal mobility, even under elevated temperatures, thereby restricting water transport. In thicker PEEK samples, the low concentration of acid reaching below the surface further reduces mass uptake, as penetration into the bulk material is minimal. Furthermore, aging increases the material's crystallinity through the formation of well-ordered molecular chains, which further hinders acid diffusion into the deeper layers of the material.(55)

The highest solubility was observed in specimens stored in physiological saliva, followed by artificial saliva, NaCl, and distilled water. This indicates that the complex composition of natural saliva promotes greater material solubility compared to simpler or synthetic solutions. Physiological saliva contains a dynamic mix of organic and inorganic components—including electrolytes (Na^-, K^-, Cl^-), urea, and over 400 proteins—whose concentrations vary among individuals and throughout the day. These fluctuations likely influenced the solubility outcomes, particularly due to differences in protein content between natural and artificial saliva. Given the limited research on material behavior in natural or artificial saliva, especially physiological saliva, further studies are warranted.(56,57) Liebermann et al. (2016),(58) reported that PEEK exhibited notable solubility regardless of the storage medium used. However, PEEK demonstrated the least material loss, indicating superior resistance to solubility compared to the other materials. These results reinforce the idea that materials with a higher resin matrix content and fewer filler particles tend to absorb more water. Since filler particles do not absorb water, an increased resin matrix may contribute to filler-matrix separation and potentially lead to hydrolytic degradation.(56)

The findings indicated that water absorption was primarily affected by the material type and storage duration, rather than the storage medium. Prolonged exposure led to increased water uptake, aligning with previous studies on composite resins. Materials with a higher resin matrix and lower filler content absorbed more water, which may contribute to filler–matrix separation and hydrolytic degradation.(56-59)

Polymers with greater structural homogeneity tend to exhibit lower water absorption and solubility(60) CAD/CAM materials, manufactured under controlled industrial conditions, benefit from reduced porosity and more consistent mechanical performance (61). Previous studies have shown that microhybrid composite resins stored in saliva, alcohol, or acidic by-products can experience surface degradation, although pH fluctuations alone had limited impact (56,59,62). Additionally, earlier research indicates that the most significant changes in the mechanical and physical properties of polymer-based materials typically occur within the first 30 days of aging (63)). Consequently, this study extended the evaluation period to assess long-term changes in retention.

The null hypothesis of this study proposed that there would be no significant difference in the retention of PEEK and TESSERA vonlays when exposed to different storage media Based on our study results, the null hypothesis was rejected as a statistically significant difference was found in as TESSERA vonlays showed higher retention compared to PEEK before, after acid and after saliva immersion.

CONCLUSIONS

Vonlays offer a promising treatment option for endodontically treated premolars, as they support the preservation of tooth structure and align well with the principles of minimally invasive dentistry. Additionally, they are suitable for promoting biointegration. This approach provides a conservative solution for restoring the function and esthetics of nonvital posterior teeth.

A statistically significant difference was found between PEEK and TESSERA in terms of retention, indicating notable material-dependent behavior under both storage conditions.

RECOMMENDATIONS

Further studies are recommended using various storage media to establish comprehensive guidelines for evaluating and optimizing retention.

LIMITATIONS

Conflict of Interest: The authors declare no conflicts of interest.

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