Egyptian Prosthodontic Association (EPA Newsletter)

Case Report: Comparison of 3D-Printed and Milled PEEK Inlays in a Lower First Molar

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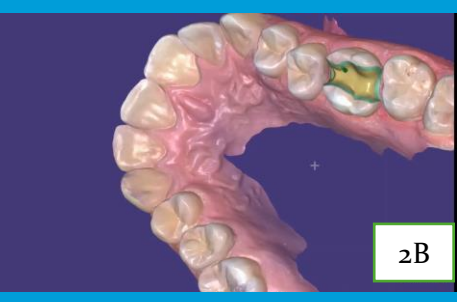
Case Presentation :

A split mouth case report comparative study was carried out within the Department of fixed prosthodontics , Beni-suef university. A 32-year-old male patient presented with a defective amalgam restoration in the lower right and left first molar . Clinical and radiographic examination revealed a large Class II cavity with sufficient remaining tooth structure to support an inlay restoration. After discussing treatment options, the patient consented to participate in a comparative split mouth evaluation of 3D-printed Vs milled PEEK inlays.

The cavity preparation began by determining the initial cavity shape based on the extent of the amalgam restoration. The opposing walls of the cavity were prepared with a divergence angle ranging from 6 to 8 degrees to ensure proper retention and resistance form. All internal angles were smoothed to eliminate sharp edges and reduce stress concentration, and the cavity margins terminated in enamel. The pulpal floor depth was maintained at a minimum of 1.5 mm to provide adequate structural support for the inlay Fig. (1A). Following the cavity preparation, immediate dentin sealing was performed using a universal adhesive system (Single Bond Universal Adhesive; 3M ESPE) in a self-etching mode. This step aimed to protect the dentin and enhance the bond strength of the restoration. The enamel margins and the composite resin liner were refined and polished using round-ended diamond rotary instruments, followed by the application of a polishing system (Super Snap XTreme; Shofu Dental Inc) to ensure a smooth surface finish. Both cavities were scanned intraorally using a high-resolution digital scanner (CS3600; Carestream Dental LLC). The scanned data was imported into a dental design software program (Dental CAD 3.1 Rijeka; exocad GmbH) to create the virtual design of the restoration Fig (1B). Two types of PEEK inlays were fabricated using distinct methods: Milled PEEK Inlays: The BioHPP PEEK inlays were milled under wet conditions using a 5-axis milling machine (Coritec 250i; imes-icore GmbH) to ensure high precision and surface integrity. 3D-Printed PEEK Inlays: The PEEK inlays were also fabricated using the fused deposition modeling (FDM) printing technique (Creatbot PEEK 300; Henan


1A

2B

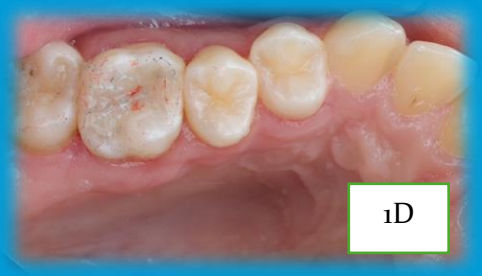
Creatbot Technology Limited) to achieve detailed anatomical features. All inlays were then finished and polished using specialized finishing burs and polishing disks (Super Snap Buff; Shofu Dental Inc) to achieve a high-gloss surface suitable for cementation.

The cementation process began with verifying the fit and adaptation of each inlay. Before bonding, the intaglio surfaces of the inlays and the sealed dentin of the prepared teeth were subjected to airborne-particle abrasion for 10 seconds using 50-µm Al_2O_3 particles. The abrasion process was performed at a pressure of 0.4 MPa, delivered at a 45-degree angle and a 10-mm distance, to increase surface roughness and enhance bonding. The surfaces were then thoroughly cleaned using an air-water spray for 10 seconds, followed by 10 seconds of air drying. Surface treatment included etching with 32% phosphoric acid for 15 seconds, after which the surfaces were rinsed with an air-water spray for 10 seconds and air-dried for another 10 seconds. An autopolymerized universal bonding agent (Palfique Universal Bond; Tukuyama Dental Corp) was applied to the sealed dentin and the intaglio surfaces of the inlays according to the manufacturer's instructions. The bonding agent was gently air-dried without light polymerization to ensure even distribution. The mixed dual-cure resin cement paste (ESTECEM Plus; Tukuyama Dental Corp) was then applied to the intaglio surfaces of the inlays and the corresponding tooth surfaces Fig.(1C). The inlays were seated using consistent and firm pressure to ensure proper adaptation.

Glycerin gel (Sensient Beauty; Rue de Industries) was applied along the restoration margins to prevent oxygen inhibition, followed by a brief tack polymerization for 2 to 4 seconds to remove excess cement in its gel state. Final cement hardening was achieved through additional light polymerization for 20 seconds from each surface to ensure complete curing fig.(1D).

The clinical performance of the restorations was assessed at three distinct intervals: immediately after cementation (T0), at 6 months (T1), and at 12 months (T2). Evaluations were conducted using written criteria based on modified United States Public Health Service (USPHS) standards. Several key parameters were examined, including marginal adaptation, where the restoration margins were checked for continuity and the absence of gaps or microleakage; occlusal adjustment, where the restorations were evaluated for occlusal harmony and any necessary corrections were documented; and patient satisfaction, where patients reported their comfort and functional satisfaction with the restorations during follow-up visits. The clinical assessment generated ordinally structured data, enabling analysis of outcomes and determining the success of the restorations over time.


1C


1D

Results

For **marginal adaptation**, **occlusa adjustment**, and **Patient satisfaction**, , alfa scores were consistently high across the two restorations **.** The study found that marginal adaptation for both 3D-printed and milled PEEK restorations achieved high alpha scores, with no significant differences in performance across the groups. These results align with previous research showing that milled PEEK restorations provide excellent marginal precision, leading to high clinical satisfaction (Kern et al., 2015; Guazzato et al., 2004). The positive outcomes are attributed to advanced fabrication techniques such as precise milling using 5-axis machines (Liu et al., 2021; Winstanley et al., 2020) and 3D printing, which helps to reproduce intricate details and minimize polymerization shrinkage (Zhao et al., 2020; Alharbi et al., 2017). However, discrepancies in the marginal and internal fit between 3D-printed and milled restorations have been reported, often due to variations in printer models, settings, and material properties (Al-Harbi et al., 2018; Yoon et al., 2019). Polymer-based materials like PEEK show better marginal adaptation than ceramics due to their superior machinability and lower brittleness (Zhao et al., 2020; Stansbury & Idacavage, 2016). Milled PEEK offers better surface finishes and predictable results (Kern et al., 2015; Schwitalla & Müller, 2013), while 3D-printed PEEK excels in material efficiency and the ability to create customized, complex geometries (Stansbury & Idacavage, 2016; Alharbi et al., 2016). However, 3D-printed PEEK may have slightly rougher surfaces and depend on post-processing, while milled PEEK requires specialized equipment (Alharbi et al., 2016; Rosentritt et al., 2015). Both methods demonstrate clinical efficacy, but their advantages and limitations depend on the specific clinical context. Further studies with larger sample sizes and longer follow-up periods are needed to confirm these findings and guide material selection.

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