Onlay restoration with direct metal laser sintering technology: A digital approach to prosthetic repair.

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Abstract

Introduction: Full-mouth rehabilitation aims to restore function, aesthetics, and occlusion in patients with extensive dental wear, damage, or previous prosthetic failure. The selection of materials and techniques significantly influences the long-term success of the prosthesis.

Case characteristics: A patient reported to the department with chief complaints of a fractured porcelain-fused-to-metal (PFM) bridge. After evaluating the dislodged prosthesis, an intraoral scan of the existing condition was performed. A digital workflow was utilized to design a new onlay restoration. A Direct Metal Laser Sintering (DMLS) metal framework was fabricated and tried in the patient's mouth, followed by PFM layering. The final prosthesis was cemented using resin cement and occlusion was carefully adjusted.

Conclusion: The integration of digital dentistry and DMLS technology provides a precise and efficient approach to rehabilitate prosthetic failures. This case highlights the importance of digital scanning, CAD-CAM designing, and metal laser sintering in achieving optimal prosthetic outcomes.

Keywords: Digital Dentistry, Direct Metal Laser Sintering, Full-mouth rehabilitation, Porcelain-fused-to-metal, Prosthetic Failure.

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Email address: - sim291097@gmail.com **Phone no:** - 7721991542. **DOI:** 10.5281/zenodo.15549359
Submitted: 15-Apr-2025 **Revised**: 22-Apr-2025 **Accepted:** 22-May-2025 **Published:** 25-May-2025
Bibliographic details: Journal of Orofacial Rehabilitation Vol. 5(1), May 2025, pp. 35-39.

Introduction

Full-mouth rehabilitation (FMR) refers to the extensive restorative procedure used to restore oral function, esthetics, and occlusal balance in patients who have experienced significant dental breakdown. Patients typically present with multiple missing teeth, worn dentition, or prosthetic failure, necessitating a multidisciplinary and methodical treatment approach. The success of FMR depends on accurate diagnosis, appropriate material selection, and meticulous prosthesis fabrication techniques.

Traditional FMR protocols have relied on analogue procedures, including conventional impressions and wax-ups. However, the introduction of digital dentistry has transformed clinical workflows. Intraoral scanners, CAD/CAM systems, and additive manufacturing have enhanced the predictability, speed, and quality of prosthetic restorations.[1] These innovations also reduce human error and material inconsistencies, leading to improved patient outcomes.

Direct Metal Laser Sintering (DMLS) is an advanced additive manufacturing process that fabricates metal frameworks directly from CAD data by sintering metal powder using a high-powered laser.[2] This technique allows for superior marginal accuracy, reduced

porosity, and excellent mechanical properties compared to traditional casting methods.[3] This case report describes the use of DMLS in the rehabilitation of a fractured PFM prosthesis as part of a digital full-mouth rehabilitation.

Case Report

A 58-year-old male patient, Mr. Rajnikant, presented to the department with a complaint of a fractured PFM bridge in the maxillary arch (Figure 1). He had undergone a full-mouth rehabilitation eight years prior and expressed dissatisfaction with the compromised esthetics and function due to the dislodged prosthesis. Clinical and radiographic examinations confirmed that the abutment teeth were periodontally sound, with no signs of recurrent caries or infection. The old prosthesis was removed, and an intraoral scan was performed using the Primescan scanner (Cerac, Dentsply Sirona), which captured high-resolution digital impressions of both arches (Figure 2). Digital impressions were chosen to eliminate inaccuracies associated with traditional impression materials and trays.[4]

The scans were imported into Exocad CAD software (Germany), where a new design for an onlay-retained PFM bridge was created (Figure 3). After approval of the virtual wax-up, the framework was fabricated using DMLS technology with a cobalt-chromium alloy (Figure 4). This layer-by-layer technique provided a framework with excellent fit and strength, reducing internal flaws and minimizing material wastage (Figure 5).[5]

Following framework fabrication, a trial was conducted to assess intraoral fit, stability, and occlusal clearance. Once verified, the framework was veneered with ceramic to mimic natural tooth morphology and achieve esthetic integration. The final prosthesis was cemented using dual-cure resin cement (RelyX U200, 3M ESPE), following proper surface treatment of the abutments and internal surface of the prosthesis (Figure 6). Occlusion was checked and adjusted meticulously to eliminate premature contacts and distribute occlusal loads evenly. Post-operative photographs confirmed the esthetic and functional success of the prosthesis.

Discussion

The introduction of digital workflows in prosthodontics has significantly improved the precision and efficiency of treatment. Intraoral scanners eliminate patient discomfort and reduce the potential for errors related to material expansion, shrinkage, or tray distortion associated with traditional impression techniques.[6] They also facilitate instant data storage and easy communication with dental laboratories. DMLS, as used in this case, represents a paradigm shift in prosthetic framework fabrication. Unlike traditional casting, DMLS does not require wax patterns, investment materials, or burnout procedures, thereby minimizing human error and material distortion.[7] Kohorst et al. demonstrated that frameworks produced via DMLS exhibit superior mechanical properties and marginal fit compared to conventionally cast frameworks.

Furthermore, the mechanical strength of DMLS frameworks makes them suitable for long-span bridges and full-arch restorations. These frameworks resist fatigue and distortion under functional loads, making them ideal for patients with high occlusal forces or bruxism.[8] The use of cobalt-chromium in DMLS adds to the durability, corrosion resistance, and biocompatibility of the final prosthesis.[9] From an esthetic perspective, veneering the DMLS framework with ceramic offers a harmonious blend of strength and natural appearance. However, success depends on proper framework design and

uniform support for the veneering ceramic. Harianawala et al. highlighted the importance of metal-ceramic bond strength and the need for proper oxide layer formation for longevity.[10] Proper cementation protocols are crucial in ensuring the long-term success of fixed prostheses. Dual-cure resin cements offer superior bond strength and reduced microleakage compared to traditional glass ionomer cements.[11] Pretreatment procedures like air abrasion of the internal surface and use of primers enhance micromechanical retention and chemical bonding. Occlusal equilibration is another key factor. In this case, articulating paper was used to verify contacts in centric and eccentric positions. Adjustments were made to prevent undue stress on individual abutments, thus preserving periodontal health and prosthesis longevity.

Digital dentistry continues to evolve with new materials, scanners, and software updates. As such, clinicians must remain updated with current technologies to offer the best care possible. This case exemplifies the benefits of integrating modern digital workflows into routine prosthodontic practice.

Conclusion

This case report demonstrates the successful management of prosthetic failure using a fully digital workflow and Direct Metal Laser Sintering technology. The precision, strength, and esthetic results achieved highlight the advantages of combining intraoral scanning, CAD-CAM designing, and additive manufacturing. As digital dentistry advances, it offers more predictable, time-efficient, and patient-friendly options for complex rehabilitations. Clinicians should embrace such technologies to enhance clinical outcomes and improve the long-term success of prosthetic treatments.

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FIGURES

Figure 1

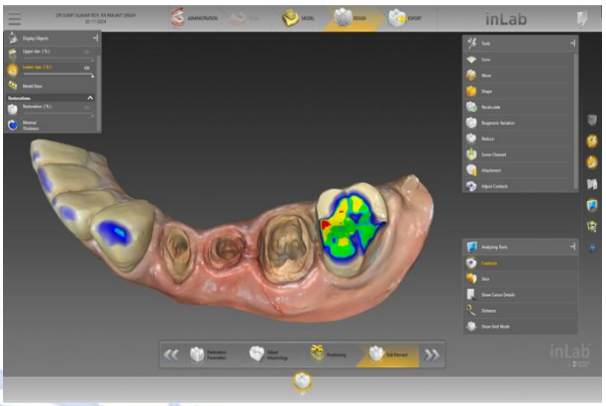

Figure 2

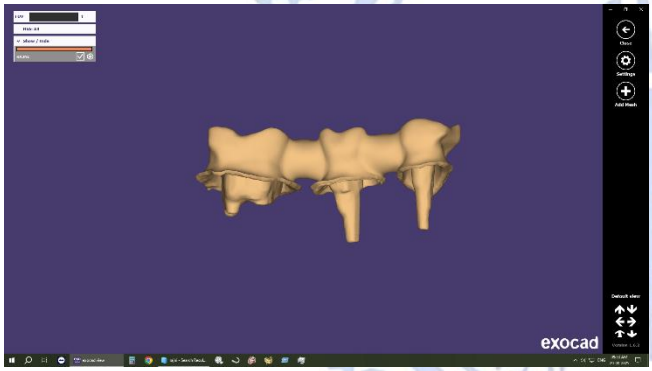

Figure 3

Figure 4

Figure 5

Figure 6