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The Current Potential of Direct Metal Laser Sintering (DMLS) in Fixed Prosthodontics

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Abstract

CAD/CAM milling and direct metal laser sintering (DMLS) methods, have brought significant advancements to prosthodontics.

In recent years, additive manufacturing techniques have gained popularity for fabricating metal substructures, particularly cobalt-chromium (Co-Cr) components.

These technologies have reduced manufacturing costs and time, while also minimizing human errors such as wax pattern distortion and casting irregularities, leading to improved fitting accuracy compared to traditional casting techniques.

Although milling techniques achieves greater accuracy, its high fabrication costs limit its practicality for daily use. In contrast, DMLS is a more cost-effective and faster technique with a slightly lower precision.

This paper briefly provides an in-depth exploration of the fundamental principles, clinical applications benefits and considerations associated with direct metal laser selective (DMLS) technology in fixed prosthodontics.

Introduction

Metal-ceramic restorations have maintained their status as the gold standard in fixed prosthodontics for several decades [1-3].

However, a persistent challenge within reconstructive dentistry revolves around the issue of veneering ceramic detachment from metal frameworks [Citation3]. Despite concerted efforts to bolster the bond strength between ceramic and metal substrates, instances of ceramic veneer fractures continue to arise intermittently in clinical practice [3-5].

For many years, metal-ceramic restorations have been crafted using the conventional lost-wax technique. Nonetheless, this approach presents various limits, including the numerous technique-sensitive stages and the occurrence of casting imperfections [6].

The alteration of metal-ceramic adhesion during the laboratory steps that may be related to disparities in thermal expansion coefficients (TEC), insufficient anatomical support, suboptimal surface roughness, metal impurities, deficient metal oxide layers on the alloy, and the presence of voids within the ceramic structure may be responsable of failures within the piece's structure [7, 3].

Attaining a precise marginal fit remains a critical prerequisite for the logivity of dental prostheses [8].

An adequate marginal fit reduces the risk of biological complications by minimizing marginal accumulation bacteria, and plaque [9].

Studies have been directed towards the fit and distortion of porcelain fused to metal crowns, with a particular focus on investigating the influence of the manufacturing technologies on marginal and internal fit of metal-ceramic fixed dental prosthesis [10].

Three dimensional metal printing has emerged as a promising additive manufacturing (AM) technique in prosthodontics, offering precision and versatility in prosthetic manufacturing [11, 12].

Direct metal laser sintering DMLS employs a high-powered laser to selectively fuse metallic powder, layer by layer, based on digital CAD models [13, 14].

This process begins with the creation of a detailed digital design, which is then sliced into successive cross-sectional layers [15].

The laser selectively sinters or melts metal powder particles, meticulously building up the desired structure with micron-level precision [16].

Studies have shown that selective laser sintering (SLS)manufactured objects present higher bond strenghts of 24 ± 10 MPa to 54 ± 14 MPa [3, 17].

In fixed prosthodontics, the 3D printing facilitates the use of biocompatible materials such as cobalt-chromium Co-Cr and feldspathic ceramics ensuring optimal compatibility and longevity.

This technology appear to have the capibility of reducing the occurrence of adhesive failures.

Researches suggested that it displays an acceptable internal marginal gap for dental applications within its manufactured products [3, 20].

Other studies have shown that 3D printing exhibited significantly lower buccal and lingual marginal discrepancies when compared to lost-wax method using die spacer [21].

While DMLS offers significant benefits such as rapid prototyping and reduced production time, it also presents limitations such as higher energy consumption [22, 23].

These products strongly depend on the regulation and standardization of the starting powder material [24, 25].

Furthermore, Scanning speed and energy output of the laser influences its physical properties and may be responsable of thermal stresses and the formation of artifacts [26] which requires special skill sets and education for the dental technician [27].

Conclusion

As research and development efforts continue to refine DMLS technology and expand its capabilities, the future of prosthodontics holds immense promise for further innovation and improvement.

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