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COMPARATIVE ANALYSIS BETWEEN CONVENTIONAL AND ADVANCED OROFACIAL FILLING TECHNIQUES IN THE DENTAL CONTEXT

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ABSTRACT

This article presents a comparative analysis of conventional and advanced orofacial filling techniques in the dental context. Conventional methods, including amalgam and incremental composite resins, have historically demonstrated predictable performance and durability, particularly in posterior teeth. However, advances in adhesive systems, bulk-fill composites, nanotechnology, bioactive restorative materials, and CAD/CAM workflows have significantly transformed restorative practice. These innovations promote minimally invasive dentistry, enhanced esthetics, and potential biological benefits, although challenges remain concerning long-term survival, operator sensitivity, and cost-effectiveness. Patient-centered decision-making and environmental considerations, such as the phase-down of amalgam, further influence clinical choices. The findings highlight that restorative strategies should integrate the best available evidence with patient needs and case-specific demands, ensuring both durability and satisfaction in modern dental practice.

Keywords: Dental Restorations. Orofacial Filling Techniques. Composite Resins. Adhesive Dentistry. Bulk-Fill Composites. Bioactive Materials. CAD/CAM Dentistry. Amalgam Alternatives.

ANÁLISE COMPARATIVA ENTRE TÉCNICAS CONVENCIONAIS E AVANÇADAS DE OBTURAÇÃO OROFACIAL NO CONTEXTO ODONTOLÓGICO

RESUMO

Este artigo apresenta uma análise comparativa de técnicas convencionais e avançadas de obturação orofacial no contexto odontológico. Os métodos convencionais, incluindo amálgama e resinas compostas incrementais, têm demonstrado historicamente desempenho e durabilidade previsíveis, particularmente em dentes posteriores. No entanto, os avanços em sistemas adesivos, compósitos de preenchimento em massa, nanotecnologia, materiais restauradores bioativos e fluxos de trabalho CAD/CAM transformaram significativamente a prática restauradora. Essas inovações promovem a odontologia minimamente invasiva, estética aprimorada e potenciais benefícios biológicos, embora ainda existam desafios relacionados à sobrevivência a longo prazo, sensibilidade do operador e custo-efetividade. A tomada de decisão centrada no paciente e as considerações ambientais, como a redução gradual do uso de amálgama, influenciam ainda mais as escolhas clínicas. Os resultados destacam que as estratégias restauradoras devem integrar as melhores evidências disponíveis com as necessidades do paciente e as demandas específicas de cada caso, garantindo durabilidade e satisfação na prática odontológica moderna.

Palavras-chave: Restaurações Dentárias. Técnicas de Obturação Orofacial. Resinas Compostas. Odontologia Adesiva. Compósitos de Preenchimento em Massa. Materiais Bioativos. Odontologia CAD/CAM. Alternativas ao Amálgama.

ANÁLISIS COMPARATIVO ENTRE TÉCNICAS DE OBTURACIÓN OROFACIAL CONVENCIONALES Y AVANZADAS EN EL CONTEXTO DENTAL

RESUMEN

Este artículo presenta un análisis comparativo de las técnicas de obturación orofacial convencionales y avanzadas en odontología. Los métodos convencionales, como la amalgama y las resinas compuestas incrementales, han demostrado históricamente un rendimiento y una durabilidad predecibles, sobre todo en los dientes posteriores. Sin embargo, los avances en sistemas adhesivos, composites de relleno masivo, nanotecnología, materiales restauradores bioactivos y flujos de trabajo CAD/CAM han transformado significativamente la práctica restauradora. Estas innovaciones promueven una odontología mínimamente invasiva, una estética mejorada y posibles beneficios biológicos, si bien persisten desafíos en cuanto a la supervivencia a largo plazo, la sensibilidad del operador y la rentabilidad. La toma de decisiones centrada en el paciente y las consideraciones ambientales, como la reducción progresiva del uso de amalgama, influyen aún más en las decisiones clínicas. Los hallazgos resaltan que las estrategias restauradoras deben integrar la mejor evidencia disponible con las necesidades del paciente y las exigencias específicas de cada caso, garantizando así la durabilidad y la satisfacción en la práctica odontológica moderna.

Palabras clave: Restauraciones Dentales. Técnicas de Obturación Orofacial. Resinas Compuestas. Odontología Adhesiva. Composites de Relleno Masivo. Materiales Bioactivos. Odontología CAD/CAM. Alternativas a la Amalgama.

1 INTRODUCTION

The selection and execution of restorative filling techniques lie at the intersection of material science, clinical protocol, and patient-centered decision-making. Historically, conventional restorative approaches—most notably dental amalgam and early-generation composite resins placed using incremental layering—offered robustness and a predictable clinical track record. More recent “advanced” techniques emphasize adhesion, biomimetics, and bioactivity to better mimic or support tooth biology and patient esthetic preferences. Systematic evidence has shown that traditional amalgam restorations have a long clinical lifespan and comparatively lower failure rates than many earlier composite systems, particularly in high-load posterior applications (Worthington et al., 2021).

Nevertheless, the landscape of direct restoratives has changed substantially due to advances in adhesive systems, new filler and resin chemistries, and the advent of ion-releasing and bioactive restorative materials. Adhesive dentistry—through etch-and-rinse and self-etch strategies, and more recently “universal” adhesives—has enabled more conservative cavity preparations and reliable bonding to enamel and dentin when properly applied, improving the prognosis of resin-based restorations in many clinical scenarios (Van Meerbeek et al., 2020). These adhesive advances underpin many modern restorative techniques, including minimally invasive, biomimetic approaches designed to preserve sound tooth structure while optimizing the resin–tooth interface.

A major domain of innovation has been bulk-fill composites and high-performance nanofilled composites. Bulk-fill formulations address clinical efficiency by permitting the placement of thicker increments while aiming to control polymerization shrinkage stress and preserve marginal integrity. Randomized clinical trials and systematic reviews have demonstrated comparable medium-term performance between properly selected bulk-fill systems and traditional incremental layering composites for posterior restorations, although adhesive technique and curing remain crucial determinants of success (Tung et al., 2022).

Parallel to compositional refinements, the introduction and optimization of ion-releasing and bioactive restorative materials—including modern glass ionomer cements, resin-modified glass ionomers, and newer hybrid “bioactive” composites—seek to go beyond passive restoration to actively influence the local microenvironment. These materials can release fluoride, calcium, or phosphate ions to support remineralization and potentially reduce secondary caries risk. While in vitro and short-term clinical data are encouraging about ion release and local buffering capacity, long-term clinical evidence demonstrating superior survival is still heterogeneous (Moshaverinia & Ansari, 2021).

Material microstructure and nanotechnology have also influenced clinical outcomes. Incorporation of nanoscale fillers and optimized silane coupling has improved mechanical properties, polishability, and wear resistance of contemporary composites, narrowing the historical performance gap between esthetic resin restoratives and metallic materials. Nano-hybrid formulations demonstrate improved physical properties in laboratory testing and favorable short-to-medium-term clinical outcomes (Ilie & Hickel, 2021).

In addition to material-level innovation, digital workflows and CAD/CAM restorative strategies represent an advanced technical pathway that changes how restorations are fabricated. Chairside CAD/CAM systems permit fabrication of monolithic ceramic or composite restorations with high precision, reducing laboratory turnaround and enabling single-visit indirect restorations that may outperform direct restorations for larger defects. Systematic reviews indicate that CAD/CAM restorations can offer excellent marginal fit and satisfactory clinical survival when materials and milling protocols are appropriately matched to the clinical indication, but cost and operator learning curve remain limitations (Zimmermann et al., 2020).

From a failure-mode perspective, conventional amalgam restorations are more often replaced for esthetic reasons, whereas composite failures are typically associated with secondary caries and marginal breakdown—issues tied to polymerization shrinkage, adhesive interface degradation, and operator technique. Meta-analyses suggest that composite restorations have historically shown higher failure rates than amalgam in posterior teeth, but improvements in adhesives and composite formulations may reduce these differences (Opdam et al., 2014).

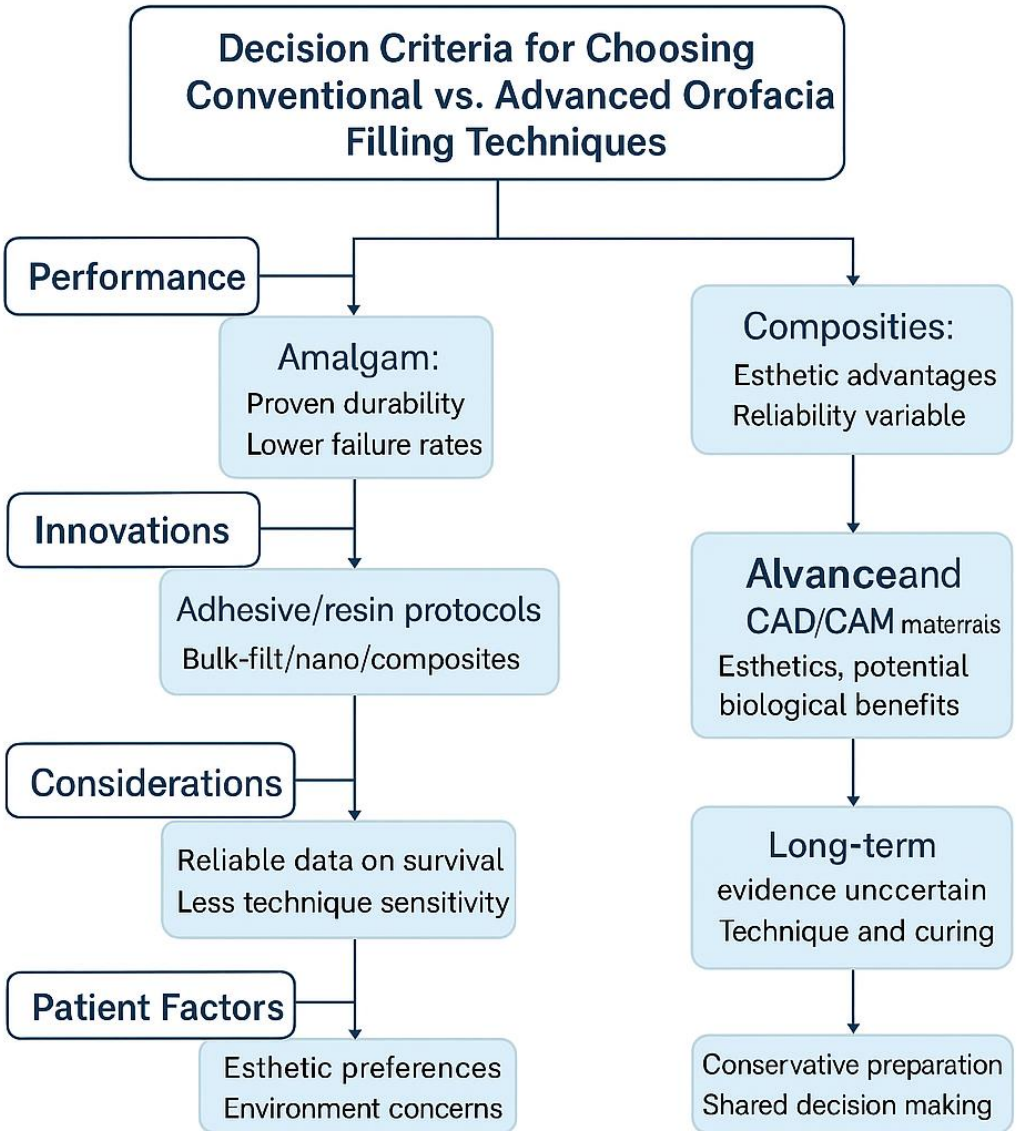
Patient-centered considerations are also central to the comparison. Modern patients frequently prioritize esthetics and prefer metal-free restorations, and environmental policies such as the Minamata Convention have accelerated the phase-down of dental amalgam. Advanced techniques can enable more conservative tooth preparations and improved esthetic integration, contributing to patient satisfaction that conventional materials may not achieve (Mjor, 2018). Clinicians must, however, communicate transparently about trade-offs, including technique sensitivity and long-term evidence.

The flowchart illustrates the decision-making process for selecting between conventional and advanced orofacial filling techniques by highlighting four main categories: performance, innovations, considerations, and patient factors. On the conventional side, amalgam is emphasized for its proven durability and lower failure rates, supported by reliable survival data and reduced technique sensitivity. In contrast, advanced techniques, such as modern composites, bulk-fill and nano-composites, bioactive materials, and CAD/CAM

restorations, are valued for their esthetic integration and potential biological benefits, though their reliability can vary and long-term evidence remains less certain. Ultimately, the diagram underscores that patient preferences, environmental concerns, and shared decision-making play crucial roles in determining the most appropriate restorative strategy.

Figure 1

Decision Criteria for Choosing Conventional vs. Advanced Orofacial Filling Techniques.



In conclusion, the dichotomy between conventional and advanced orofacial filling techniques is less a binary than a continuum shaped by evolving materials science, adhesive technology, digital workflows, and public health considerations. Amalgam remains a benchmark for durability, but advances in adhesives, bulk-fill and nanocomposites, bioactive restoratives, and CAD/CAM technologies provide clinicians with powerful alternatives that align with patient demands and contemporary practice. The clinical imperative is thus to integrate evidence-based protocols with patient values and case-specific factors, favoring

restorative strategies supported by robust clinical data while monitoring the long-term outcomes of newer approaches.

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