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Clinical Performance of Modern Dental Biomaterials: A Systematic Review of Aesthetic and Functional Restoration

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Abstract
Background: Modern dentistry has witnessed remarkable advancements in biomaterials designed to improve both aesthetic outcomes and functional performance in restorative treatments. Materials such as ceramics, resin composites, zirconia, bioactive glass, and hybrid materials have significantly transformed clinical practice by offering enhanced durability, biocompatibility, and aesthetic integration with natural dentition.
Objective: This systematic review aims to evaluate the clinical performance of modern dental biomaterials in achieving aesthetic and functional restoration outcomes.
Methods: A systematic search was conducted across major databases including PubMed, Scopus, Web of Science, and Embase to identify relevant clinical and laboratory studies published in recent years. Studies evaluating restorative biomaterials in terms of aesthetics, durability, mechanical strength, longevity, and patient satisfaction were included. The study selection process followed PRISMA guidelines.
Results: The included studies demonstrated that modern biomaterials, particularly zirconia-based ceramics, nanocomposite resins, and bioactive materials, provide improved mechanical strength, enhanced esthetics, and long-term clinical stability.
Conclusion: Advanced dental biomaterials significantly enhance restorative outcomes by combining aesthetic excellence with functional durability, supporting their widespread adoption in contemporary restorative dentistry.
Keywords: Dental biomaterials, restorative dentistry, zirconia, nanocomposites, bioactive materials, aesthetic dentistry.

Introduction

The field of restorative dentistry has undergone significant transformation over the past few decades due to rapid advances in dental biomaterials. The primary goal of restorative dental treatment is to repair damaged or diseased teeth while restoring both their functional integrity and aesthetic appearance. Achieving this balance requires materials that possess excellent mechanical strength, durability, biocompatibility, and optical properties that closely mimic natural tooth structures (Ferracane, 2011;

Kelly & Benetti, 2011). Consequently, the development of modern dental biomaterials has become a major focus in dental research and clinical practice.

Dental biomaterials are defined as natural or synthetic materials designed to replace or restore the structure and function of damaged oral tissues. Historically, restorative dentistry relied heavily on materials such as dental amalgam, gold alloys, and early silicate cements. Although these materials offered acceptable durability and mechanical stability, their aesthetic limitations and concerns regarding biocompatibility led to increased demand for more advanced alternatives (Anusavice, Shen, & Rawls, 2013). The growing emphasis on minimally invasive dentistry and patient-centered care has further accelerated the development of biomaterials that can provide natural aesthetics while preserving tooth structure.

Modern dental biomaterials now include a wide range of materials such as resin-based composites, glass ionomer cements, ceramics, zirconia, and bioactive materials. Among these, ceramic-based restorations—particularly lithium disilicate and zirconia—have gained widespread popularity due to their superior mechanical strength, excellent translucency, and long-term clinical performance (Manicone, Rossi Iommetti, & Raffaelli, 2007). Similarly, advancements in resin composite technology, including nanofilled and nanohybrid composites, have significantly improved wear resistance, polishability, and aesthetic outcomes in direct restorations (Ferracane, 2011).

In addition to aesthetic improvements, contemporary biomaterials are increasingly designed to interact positively with the biological environment of the oral cavity. Bioactive materials, for instance, are capable of promoting remineralization and forming chemical bonds with dental tissues, thereby improving the longevity and biological compatibility of restorations (Hench & Jones, 2015). These materials represent a shift from passive restorative materials toward therapeutic biomaterials that actively contribute to oral health.

Despite these advancements, challenges remain regarding the long-term clinical performance of modern dental biomaterials. Factors such as material fatigue, polymerization shrinkage, marginal degradation, and occlusal wear can affect the durability and success of restorations over time (Miletic, 2018). Therefore, continuous evaluation of the clinical performance of these materials is essential to guide evidence-based dental practice.

Given the rapid evolution of biomaterial technologies, a comprehensive evaluation of their clinical effectiveness in achieving both aesthetic and functional restoration is necessary. This systematic review aims to assess the clinical performance of modern dental biomaterials used in restorative dentistry, with particular focus on their aesthetic outcomes, mechanical reliability, and long-term durability.

Methodology

This systematic review was conducted in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)** guidelines to ensure transparency and methodological rigor in identifying, selecting, and analyzing relevant studies. The objective of this review was to evaluate the clinical performance of modern dental biomaterials used in aesthetic and functional restorative procedures.

A comprehensive literature search was performed across several major electronic databases, including **PubMed, Scopus, Web of Science, and Embase**, to identify relevant studies published between **2016 and 2025**. The search strategy incorporated a combination of keywords and Medical Subject Headings (MeSH) terms related to dental biomaterials and restorative dentistry. The primary search terms included *"dental biomaterials," "restorative dentistry," "zirconia restorations," "resin composites," "ceramic restorations," "bioactive dental materials," "aesthetic dentistry,"* and *"clinical performance."* Boolean operators such as **AND** and **OR** were applied to refine the search and ensure comprehensive coverage of relevant literature.

Studies were included if they met the following criteria: (1) evaluated modern dental biomaterials used in restorative dentistry; (2) assessed clinical or laboratory outcomes related to aesthetic or functional restoration; (3) were published in peer-reviewed journals; and (4) were written in English. Both **clinical trials, cohort studies, and in vitro investigations** examining mechanical properties, durability, aesthetic outcomes, or biocompatibility were considered eligible for inclusion.

Studies were excluded if they were **case reports, editorials, conference abstracts without full data, or review articles**, as the purpose of this study was to synthesize primary research evidence. Additionally, studies lacking clear outcome measures related to restorative performance were excluded.

The study selection process involved **two independent reviewers** who initially screened the titles and abstracts of all retrieved articles. Full-text versions of potentially relevant studies were subsequently assessed to determine eligibility based on the predefined inclusion and exclusion criteria. Any disagreements between reviewers were resolved through discussion to reach consensus.

Data extracted from the selected studies included **author names, publication year, study design, type of biomaterial evaluated, sample size, evaluation methods, and key clinical outcomes related to aesthetic and functional performance**. The extracted data were then synthesized and analyzed to identify trends, strengths, and limitations in the clinical performance of modern dental biomaterials used in restorative dentistry.

Evolution of Dental Biomaterials

The development of dental biomaterials has played a critical role in shaping modern restorative dentistry. Over time, the materials used to repair and restore teeth have evolved significantly, moving from durable but aesthetically limited materials toward highly advanced biomaterials that combine mechanical strength, biocompatibility, and natural appearance. This evolution reflects both technological advances in material science and increasing patient demand for restorations that replicate the appearance and function of natural teeth.

Historically, restorative dentistry relied heavily on materials such as **gold alloys, dental amalgam, and silicate cements**. Gold was widely used due to its excellent durability, corrosion resistance, and biocompatibility. However, its high cost and poor aesthetic appearance limited its acceptance in visible areas of the mouth. Similarly, dental amalgam was extensively used in posterior restorations because of its strength and longevity, often lasting many years under heavy occlusal forces. Despite these advantages, concerns regarding aesthetics and the presence of mercury contributed to a gradual decline in the use of amalgam in favor of tooth-colored alternatives (Anusavice, Shen, & Rawls, 2013).

The introduction of **resin-based composite materials** in the second half of the twentieth century marked a major turning point in restorative dentistry. Composite resins provided a tooth-colored alternative to amalgam, enabling clinicians to perform aesthetically pleasing restorations while preserving more natural tooth structure. Early composite materials, however, had limitations such as polymerization shrinkage, reduced wear resistance, and marginal degradation. Continuous improvements in filler technology and resin matrices have led to the development of **nanocomposites and nanohybrid composites**, which exhibit improved mechanical properties, enhanced polishability, and better long-term clinical performance (Ferracane, 2011).

Another significant advancement in dental biomaterials has been the development of **ceramic materials** for restorative applications. Dental ceramics offer superior aesthetic qualities because their optical properties closely resemble those of natural enamel and dentin. Materials such as **feldspathic porcelain, lithium disilicate, and zirconia** have become widely used in crowns, veneers, and fixed dental prostheses. Lithium disilicate ceramics provide excellent translucency and aesthetic integration, making them particularly suitable for anterior restorations. In contrast, zirconia-based ceramics offer exceptional fracture resistance and mechanical strength, allowing their use in posterior restorations and multi-unit bridges (Kelly & Benetti, 2011; Manicone, Rossi Iommetti, & Raffaelli, 2007).

More recently, research in dental biomaterials has shifted toward the development of **bioactive and smart materials** that interact positively with biological tissues. Unlike traditional restorative materials that function passively, bioactive materials are capable of stimulating biological responses such as remineralization and tissue regeneration. Examples include **bioactive glass, calcium silicate-based materials, and resin-modified glass ionomers**. These materials release ions that can promote the formation of hydroxyapatite, thereby strengthening the tooth-restoration interface and improving the longevity of restorations (Hench & Jones, 2015).

Advances in **nanotechnology and material engineering** have further accelerated the evolution of dental biomaterials. Nanoparticles incorporated into dental composites enhance mechanical properties, improve wear resistance, and provide better optical characteristics. Additionally, digital dentistry and computer-aided design/computer-aided manufacturing (CAD/CAM) technologies have enabled the fabrication of highly precise restorations using advanced materials such as hybrid ceramics and high-strength zirconia (Miletic, 2018).

Overall, the evolution of dental biomaterials reflects a continuous effort to improve the aesthetic quality, functional durability, and biological compatibility of restorative treatments. As research continues to explore innovative materials and technologies, modern dentistry is increasingly moving toward biomaterials that not only restore damaged teeth but also support long-term oral health and tissue regeneration.

Types of Modern Dental Biomaterials

Modern restorative dentistry relies on a wide range of dental biomaterials designed to restore the structure, function, and aesthetics of damaged teeth. These materials are engineered to mimic the physical, mechanical, and optical properties of natural tooth tissues while maintaining long-term clinical stability and biocompatibility. Advances in materials science have led to the development of several categories of biomaterials commonly used in contemporary dental practice, including resin-based composites, ceramic materials, glass ionomer cements, and bioactive biomaterials.

Resin-based composites are among the most widely used materials in restorative dentistry, particularly for direct restorations. These materials consist of a resin matrix reinforced with inorganic filler particles that improve mechanical strength and wear resistance. Modern composites incorporate nanotechnology, resulting in **nanofilled and nanohybrid composites** with enhanced polishability, improved aesthetic properties, and reduced polymerization shrinkage. These materials allow clinicians to achieve highly aesthetic restorations with minimal removal of healthy tooth structure. However, despite their advantages, composite materials may still experience long-term issues such as marginal degradation and wear under heavy occlusal forces (Ferracane, 2011).

Dental ceramics represent a major advancement in aesthetic dentistry due to their ability to closely mimic the optical characteristics of natural enamel. Ceramic materials offer excellent color stability, translucency, and biocompatibility. Common types of dental ceramics include **feldspathic porcelain, lithium disilicate, and zirconia-based ceramics**. Lithium disilicate ceramics are widely used for veneers, crowns, and partial coverage restorations because of their superior aesthetic properties and moderate mechanical strength. Zirconia ceramics, on the other hand, possess exceptional fracture resistance and durability, making them suitable for posterior restorations and fixed dental prostheses. Their high strength allows them to withstand substantial occlusal loads, although earlier zirconia materials had limitations related to translucency (Kelly & Benetti, 2011; Manicone, Rossi Iommetti, & Raffaelli, 2007).

Glass ionomer cements (GICs) are widely used in restorative dentistry, particularly in pediatric dentistry and minimally invasive treatments. These materials are composed of fluoroaluminosilicate glass powder and polyacrylic acid, which react to form a material capable of chemically bonding to tooth structure. One of the most important advantages of GICs is their ability to release fluoride, which helps prevent secondary caries and enhances remineralization of adjacent tooth tissues. However, conventional glass ionomer materials have relatively lower mechanical strength compared to composite resins and ceramics, limiting their use in high-stress areas of the mouth (Anusavice, Shen, & Rawls, 2013).

Bioactive biomaterials represent an emerging category of dental materials designed to interact with biological tissues and promote healing processes. Unlike traditional restorative materials that function primarily as passive replacements, bioactive materials can stimulate mineralization and improve the interface between the restoration and surrounding tooth structure. Examples include **bioactive glass, calcium silicate-based materials, and resin-modified glass ionomers**. These materials release biologically active ions such as calcium and phosphate, which contribute to the formation of hydroxyapatite and enhance the durability of restorations (Hench & Jones, 2015).

Recent advances in digital dentistry have led to the development of hybrid biomaterials designed for use with **computer-aided design and computer-aided manufacturing (CAD/CAM)** systems. Hybrid ceramics combine the mechanical strength of ceramics with the flexibility of polymer-based materials, resulting in restorations with improved shock absorption and fracture resistance. These materials are increasingly used in chairside restorations, allowing dentists to fabricate crowns and inlays in a single clinical visit (Miletic, 2018).

Table 1. Major Types of Modern Dental Biomaterials and Their Clinical Characteristics

Biomaterial Type	Common Applications	Advantages	Limitations

Resin-based composites	Direct restorations, anterior and posterior fillings	Excellent aesthetics, minimally invasive, improved polishability	Polymerization shrinkage, wear over time
Lithium disilicate ceramics	Veneers, crowns, inlays/onlays	High translucency, excellent aesthetics	Moderate fracture resistance
Zirconia ceramics	Crowns, bridges, implant-supported restorations	High strength, excellent durability	Limited translucency in some types
Glass ionomer cements	Pediatric restorations, cervical lesions	Fluoride release, chemical bonding to tooth	Lower mechanical strength
Bioactive materials	Remineralization therapies, regenerative dentistry	Stimulates mineralization and tissue interaction	Limited long-term clinical data
Hybrid CAD/CAM materials	Chairside restorations, inlays, crowns	Good fracture resistance, efficient digital fabrication	Higher cost

Overall, the wide variety of modern dental biomaterials allows clinicians to select materials based on the specific functional and aesthetic requirements of each clinical case. Continuous innovation in dental materials science is expected to further enhance the durability, biocompatibility, and aesthetic outcomes of restorative treatments.

Clinical Performance of Dental Biomaterials

The clinical performance of dental biomaterials is a critical factor in determining the success and longevity of restorative treatments. Modern restorative materials are expected to meet several clinical requirements, including mechanical durability, aesthetic integration with natural teeth, biocompatibility with oral tissues, and resistance to wear and degradation in the oral environment. Evaluating these characteristics allows clinicians to select materials that provide reliable long-term outcomes for both functional and aesthetic restorations.

One of the most important determinants of clinical performance is **mechanical strength and fracture resistance**. Dental restorations are constantly subjected to significant occlusal forces during mastication, which can lead to material fatigue and fracture over time. Ceramic materials, particularly **zirconia-based restorations**, have demonstrated excellent fracture resistance and high flexural strength, making them suitable for posterior crowns and bridges where mechanical stress is greatest. Studies have reported high survival rates for zirconia restorations due to their ability to withstand heavy functional loads (Manicone, Rossi Iommetti, & Raffaelli, 2007; Kelly & Benetti, 2011).

Another key factor influencing clinical performance is **wear resistance and durability**. Restorative materials must resist mechanical wear caused by chewing and contact with opposing teeth. Resin-based composite materials have improved significantly with the development of nanofilled and nanohybrid composites that enhance mechanical properties and reduce surface wear. These advancements allow composite restorations to maintain their structural integrity and surface smoothness for longer periods compared to earlier generations of composite materials (Ferracane, 2011).

Aesthetic performance is also a major consideration in restorative dentistry. Modern dental biomaterials are designed to replicate the optical characteristics of natural teeth, including translucency, color stability, and surface texture. Materials such as lithium disilicate ceramics provide superior aesthetic outcomes due to their high translucency and ability to blend naturally with surrounding tooth structures. These materials are particularly useful for anterior restorations where aesthetic demands are highest (Kelly & Benetti, 2011).

In addition to mechanical and aesthetic properties, **biocompatibility** plays a crucial role in determining the clinical success of dental biomaterials. Materials used in restorative procedures must be compatible with oral tissues and should not induce adverse biological reactions. Bioactive materials represent a significant advancement in this regard, as they actively interact with the surrounding biological environment. For example, bioactive glass materials release calcium and phosphate ions that promote remineralization and enhance the bond between restorative materials and tooth structure (Hench & Jones, 2015).

Another important aspect of clinical performance is the **longevity and survival rate of restorations**. Long-term clinical studies have shown that ceramic restorations such as zirconia and lithium disilicate crowns can achieve survival rates exceeding 90% over a period of five to ten years. These results demonstrate the reliability of modern ceramic materials for long-term restorative treatments. Similarly, improvements in adhesive dentistry have enhanced the bonding strength between restorative materials and dental tissues, reducing the risk of restoration failure (Miletic, 2018).

Despite these advancements, certain limitations still affect the long-term performance of dental biomaterials. Polymerization shrinkage in composite resins can lead to marginal gaps and secondary caries, while ceramic materials may still be susceptible to chipping under extreme occlusal forces. Therefore, proper material selection, clinical technique, and patient-specific factors must all be considered to ensure optimal restorative outcomes.

Overall, modern dental biomaterials have significantly improved the clinical performance of restorative treatments. Advances in material composition, nanotechnology, and adhesive systems have contributed to restorations that provide excellent durability, aesthetics, and biocompatibility. Continued research and long-term clinical evaluation remain essential to further enhance the effectiveness and reliability of dental biomaterials in restorative dentistry.

Impact on Aesthetic and Functional Restoration

Modern dental biomaterials have significantly transformed restorative dentistry by improving both aesthetic outcomes and functional performance. The development of advanced materials has allowed clinicians to restore damaged teeth in ways that closely replicate the natural structure, appearance, and mechanical behavior of healthy dentition. These improvements contribute not only to better clinical results but also to enhanced patient satisfaction and quality of life.

One of the most significant contributions of modern dental biomaterials is the improvement in aesthetic dental restoration. Patients increasingly demand restorations that are indistinguishable from natural teeth, especially in the anterior region. Materials such as **lithium disilicate ceramics, zirconia, and nanocomposite resins** provide superior optical properties that closely mimic the translucency, color, and light-reflecting characteristics of natural enamel and dentin. These materials allow clinicians to achieve highly aesthetic restorations while maintaining durability and structural integrity (Kelly & Benetti, 2011).

Ceramic materials, particularly lithium disilicate, are widely recognized for their excellent aesthetic qualities due to their high translucency and ability to replicate natural tooth morphology. This makes them ideal for veneers, crowns, and other anterior restorations where aesthetics are a primary concern. Additionally, improvements in resin composite technology have enhanced the polishability and color stability of composite restorations, enabling them to maintain their aesthetic appearance over time (Ferracane, 2011).

Another factor that contributes to aesthetic success is the **minimally invasive nature of modern restorative materials**. Adhesive dentistry allows clinicians to preserve more natural tooth structure while placing restorations. This approach not only enhances aesthetic outcomes but also helps maintain the structural integrity of the tooth. Advances in bonding systems and adhesive technologies have further improved the marginal integrity and long-term appearance of restorations (Miletic, 2018).

In addition to aesthetic improvements, modern dental biomaterials have significantly enhanced the functional performance of restorations. Functional restoration involves restoring the tooth's ability to withstand occlusal forces, maintain proper chewing efficiency, and preserve the structural stability of the dental arch.

Materials such as zirconia-based ceramics exhibit exceptional mechanical strength and fracture resistance, making them suitable for posterior restorations and multi-unit bridges that are exposed to high occlusal loads. Zirconia restorations are capable of withstanding significant functional stress while maintaining long-term durability, which has led to their widespread adoption in restorative dentistry (Manicone, Rossi Iommetti, & Raffaelli, 2007).

Composite resins also contribute to functional restoration due to their ability to bond directly to tooth structures through adhesive systems. This bonding capability improves stress distribution within the restored tooth and reduces the likelihood of restoration failure. Additionally, nanotechnology has

improved the wear resistance and mechanical properties of composite materials, allowing them to perform more reliably in posterior restorations compared to earlier generations of composites (Ferracane, 2011).
Another important advancement is the emergence of **bioactive dental materials**, which can actively interact with surrounding tissues. These materials release biologically active ions that promote remineralization and strengthen the interface between restorative materials and tooth structures. By enhancing the biological integration of restorations, bioactive materials contribute to both functional stability and long-term restoration success (Hench & Jones, 2015).
The integration of advanced biomaterials into restorative dentistry has led to improved patient satisfaction due to better aesthetic results, enhanced chewing efficiency, and longer-lasting restorations. Studies have demonstrated that restorations made from modern ceramics and composite materials can achieve high survival rates and maintain their functional and aesthetic qualities for many years when placed correctly (Kelly & Benetti, 2011).

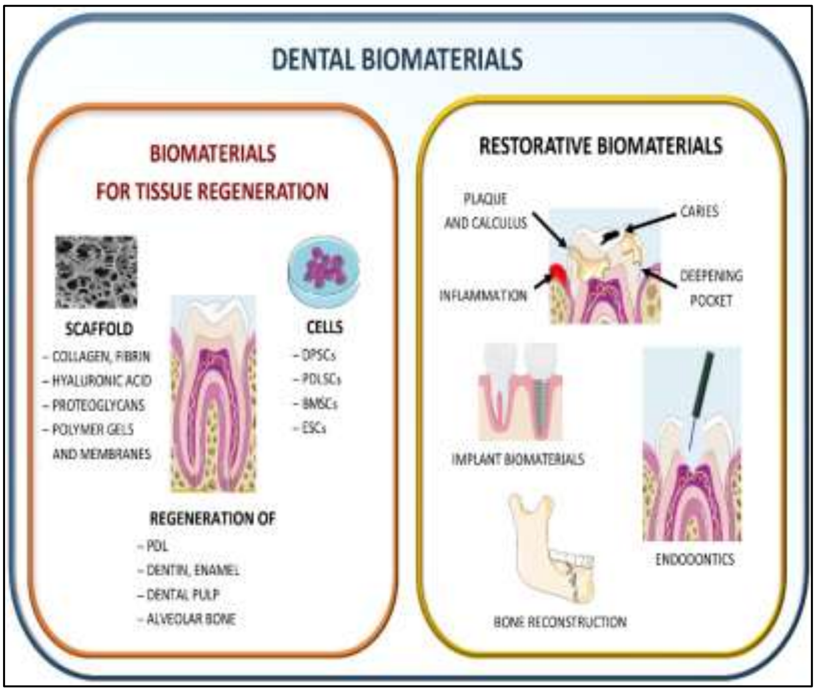

Figure 1. Conceptual Model of Dental Biomaterials in Aesthetic and Functional Restoration

This conceptual model illustrates how modern dental biomaterials influence restorative outcomes through three primary pathways: mechanical strength (supporting functional restoration), optical properties (enhancing aesthetic outcomes), and biocompatibility (supporting tissue integration and restoration longevity).
Overall, modern dental biomaterials provide a comprehensive solution for restoring both the appearance and function of damaged teeth. Their continued development is expected to further enhance restorative outcomes and support the advancement of minimally invasive and patient-centered dentistry.

Discussion

The findings of this systematic review highlight the significant progress achieved in the development and clinical application of modern dental biomaterials. Advances in material science, nanotechnology, and digital dentistry have contributed to the emergence of restorative materials capable of providing both superior aesthetic outcomes and reliable functional performance. These improvements have reshaped contemporary restorative dentistry by enabling clinicians to deliver restorations that closely replicate the natural appearance and mechanical behavior of healthy teeth.
One of the most notable findings across the reviewed literature is the improved mechanical performance of ceramic-based biomaterials, particularly zirconia and lithium disilicate. These materials demonstrate high fracture resistance and flexural strength, which make them suitable for both anterior and posterior

restorations. Zirconia restorations, for instance, have shown excellent survival rates in long-term clinical studies due to their ability to withstand significant occlusal forces without fracture (Manicone, Rossi Iommetti, & Raffaelli, 2007). Similarly, lithium disilicate ceramics provide a balance between strength and aesthetics, making them an ideal choice for restorations that require both durability and high translucency (Kelly & Benetti, 2011).

In addition to ceramic materials, the continuous improvement of resin-based composite materials has greatly expanded their clinical applications. The introduction of nanofilled and nanohybrid composites has significantly enhanced mechanical strength, wear resistance, and polishability compared to earlier composite formulations. These improvements allow composite materials to be used not only in anterior restorations but also in posterior restorations where functional demands are higher. Furthermore, the development of advanced adhesive systems has strengthened the bond between composite restorations and dental tissues, contributing to improved marginal integrity and restoration longevity (Ferracane, 2011).

Another important development in dental biomaterials is the emergence of bioactive materials that interact positively with biological tissues. Traditional restorative materials function primarily as passive substitutes for lost tooth structure, whereas bioactive materials actively participate in biological processes such as remineralization and tissue regeneration. Materials such as bioactive glass and calcium silicate-based compounds release ions that stimulate the formation of hydroxyapatite, thereby strengthening the tooth-restoration interface and improving long-term clinical outcomes (Hench & Jones, 2015). This shift toward bioactive and therapeutic materials represents an important advancement in restorative dentistry.

Despite these advancements, several challenges continue to affect the long-term performance of dental biomaterials. One of the primary concerns associated with resin-based composites is polymerization shrinkage, which can lead to marginal gaps, microleakage, and secondary caries if not properly managed. Similarly, although ceramic materials exhibit excellent strength, they may still be susceptible to chipping or fracture under extreme occlusal stress. These limitations highlight the importance of proper material selection and clinical technique in achieving successful restorative outcomes (Miletic, 2018).

Another factor influencing the success of restorative biomaterials is the increasing role of **digital dentistry technologies**, including computer-aided design and computer-aided manufacturing (CAD/CAM). These technologies enable the fabrication of highly precise restorations using advanced materials such as hybrid ceramics and high-strength zirconia. The integration of digital workflows improves restoration accuracy, reduces treatment time, and enhances overall clinical efficiency.

Overall, the evidence reviewed in this study suggests that modern dental biomaterials have significantly improved the effectiveness of restorative dentistry by combining aesthetic excellence with functional reliability. However, continued research is necessary to further enhance the durability, biological compatibility, and long-term clinical performance of these materials. Future innovations may include the development of smart biomaterials capable of responding to changes in the oral environment, as well as materials that support tissue regeneration and preventive dentistry.

Conclusion

Modern dental biomaterials have significantly transformed restorative dentistry by enabling clinicians to achieve both aesthetic excellence and reliable functional performance. The continuous development of advanced materials such as zirconia ceramics, lithium disilicate, resin-based nanocomposites, and bioactive biomaterials has expanded the possibilities for restoring damaged teeth while closely replicating the natural structure and appearance of dental tissues. These materials provide improved mechanical strength, enhanced durability, superior optical properties, and increased biocompatibility, which collectively contribute to better clinical outcomes and higher patient satisfaction.

The findings of this systematic review demonstrate that contemporary dental biomaterials play a crucial role in improving the longevity and effectiveness of restorative treatments. Ceramic materials, particularly zirconia and lithium disilicate, have shown excellent clinical survival rates and strong resistance to fracture under occlusal loads. Similarly, advancements in composite resin technology have significantly improved wear resistance, aesthetic stability, and bonding performance, making them suitable for a wide range of restorative applications. In addition, the introduction of bioactive materials represents a promising development in restorative dentistry, as these materials can promote remineralization and enhance the biological integration of restorations with surrounding tooth structures.

Despite these advancements, certain limitations remain, including polymerization shrinkage in composite materials, potential chipping in ceramic restorations, and the need for long-term clinical evidence for newer biomaterials. Therefore, careful material selection, appropriate clinical techniques, and continued research are essential to maximize the benefits of these materials in restorative dentistry.
Future research should focus on the development of **smart and regenerative biomaterials** capable of responding to the dynamic oral environment and supporting tissue regeneration. Additionally, the integration of digital dentistry technologies and biomaterial innovation is expected to further improve the precision, efficiency, and long-term success of restorative treatments.
In conclusion, modern dental biomaterials represent a fundamental component of contemporary restorative dentistry. Their ongoing development will continue to redefine the standards of aesthetic and functional dental restoration, ultimately improving oral health outcomes and patient quality of life.

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