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PMMA IN DENTISTRY: A MODERN SOLUTION FOR SUSTAINABLE DENTAL RESTORATIONS

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Abstract

Polymethylmethacrylate (PMMA) is a polymeric material widely used in dentistry due to its biocompatibility, durability and superior aesthetics. This article explores the essential properties of PMMA and its various applications in dentistry. PMMA is ideal for dentures due to its comfort and ease of adjustment, temporary crowns and bridges due to easy shaping and processing, as well as transparent orthodontic appliances for their discreet aesthetics. In addition, PMMA is used in maxillofacial surgery for surgical guidelines and planning models, temporary veneers, and dental mock-ups for visualizing the final results of aesthetic treatments. PMMA's durability, wear resistance and dimensional stability ensure the long-lasting performance of dental restorations. Recent innovations include additives that improve mechanical and antibacterial properties, thus increasing its applicability in dentistry. PMMA remains a reference material in modern dental practice, offering aesthetic, durable and comfortable solutions for patients, with the promise of continuous innovations that further improve the performance of this versatile material.

Keywords*:* polymethylmethacrylate (PMMA); dental restorations; biocompatibility; aesthetics; sustainability.

Introduction

PMMA is used for dental restorations that must meet strict requirements for durability, biocompatibility, and aesthetics. PMMA (polymethyl methacrylate) has become one of the preferred materials due to its ability to meet these criteria. The use of PMMA in dentistry has increased significantly in recent decades, reflecting technological advancements and increasing patient demands for aesthetic and sustainable solutions [1-3].

Polymethylmethacrylate (PMMA), also known as plexiglass, is a synthetic polymer with a wide range of applications in various fields, including dentistry. Due to its outstanding properties, PMMA has become a staple material in dental restorations. The history of PMMA use in dentistry dates back to the 1930s, when it was first introduced as a denture material. In the decades that followed, the use of PMMA expanded significantly due to continuous improvements in its formulations, which increased the biocompatibility, durability, and aesthetics of the material [1-3].

PMMA's biocompatibility is one of the most important factors contributing to its popularity in dentistry. The material is well tolerated by oral tissues and does not cause significant allergic reactions or irritation, making it ideal for long-term use. In addition, PMMA has excellent resistance to wear and fractures, thus ensuring the durability of dental restorations made of this material [3-5].

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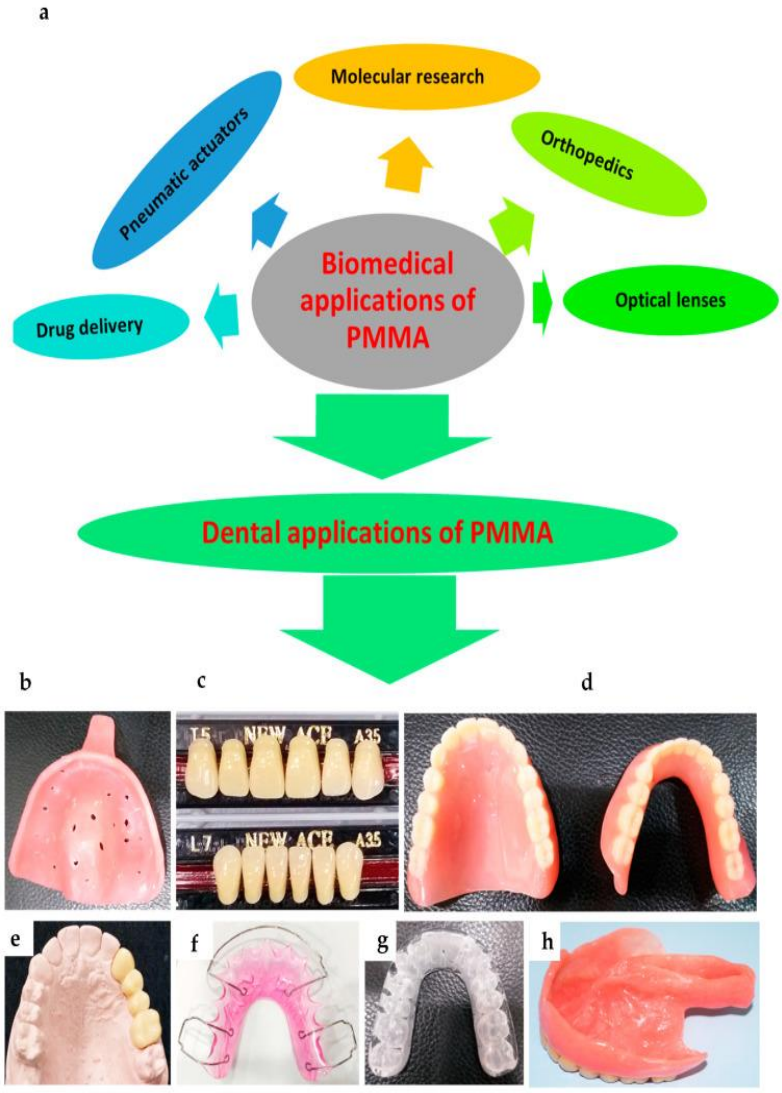

Fig 1. It presents the main applications of PMMA: a) a diversity of biomedical disciplines, b) individual spoon for secondary impression purposes, c) acrylic artificial teeth gasket, d) totally mobile prosthesis with acrylic teeth, e) partial temporary fixed bridge, f) orthodontic plate g) occlusal aligner, h) palatine obturator [3].

The superior aesthetics of PMMA is another major advantage. Due to its transparency and ability to be colored to match the natural shade of the teeth, PMMA allows for the creation of dental restorations that are almost indistinguishable from natural teeth. This is particularly important in the context of dental crowns and bridges, where aesthetic appearance plays a crucial role [3,4].

In dentistry, PMMA is used in a variety of applications, including in the making of dental crowns and bridges, dentures, and temporary implants. Dental crowns and bridges made of PMMA are often used as temporary solutions, due to the ease with which the material can be shaped and adjusted. Recently, improved PMMA formulations have allowed the use of this material in permanent restorations [4-6].

PMMA dentures offer increased comfort to patients, being lightweight and well tolerated by oral tissues. In addition, PMMA allows for precise adjustments, ensuring a perfect fit and reducing the risk of irritation or discomfort. Temporary dental implants made of PMMA offer an effective solution up to the integration of permanent implants [3-6].

Recent innovations in PMMA formulations have led to the development of nanocomposites that include additives such as zirconium oxide or silver nanoparticles. They improve the mechanical and antibacterial properties of the material, making it even more attractive for use in dentistry. Also, PMMA formulations that include plasticizers or elasticizing agents contribute to the creation of more comfortable dentures, reducing irritation and pressure points [3-6].

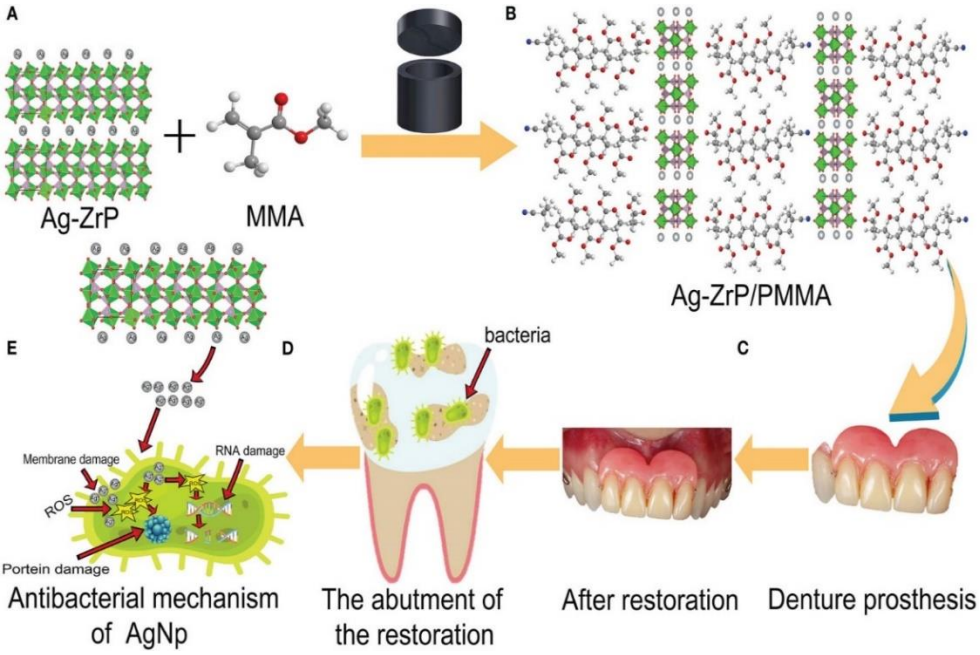

Fig 2. A and B) show a schematic diagram of the process of integration of nano-Ag-ZrP into the PMMA material, C) show a denture made of the nano-Ag-ZrP/PMMA composite d) highlight the use of this material for restorative abutments that are difficult to clean and prone to bacterial adhesion, E) illustrate the release of silver ions (Ag+) by nano-Ag-ZrP, generating an antibacterial effect [6].

PMMA continues to be an essential material in dentistry due to its outstanding properties and continuous innovations that improve its performance. The use of PMMA in dental restorations provides significant benefits to both patients and dental professionals, ensuring durable, aesthetic, and comfortable solutions [3-6].

Biocompatibility

The biocompatibility of dental materials is essential for the long-term success of dental restorations. PMMA (polymethyl methacrylate) stands out for its excellent biocompatibility, which makes it a particularly valuable material in dentistry. Its ability to be well tolerated by

oral tissues without causing significant side effects is a major advantage. PMMA does not cause allergic reactions or inflammation, thus ensuring optimal comfort for patients [6-9].

The material has outstanding chemical stability, which reduces the risk of toxic substances being released into the oral cavity. PMMA is also chemically inert, which helps maintain the health of surrounding tissues. In the context of dental prostheses, PMMA biocompatibility is crucial for the prevention of irritation and ulceration of the oral mucosa, essential aspects for patient comfort and health [7-9].

The biocompatibility of PMMA is supported by numerous clinical studies that demonstrate the safety of its long-term use. In addition, PMMA allows for harmonious integration with oral tissues, which contributes to the stability and functionality of dental restorations. The material is widely used in the manufacture of dentures, temporary implants and temporary restorations, due to its reliable biocompatible profile [7,8].

Another important aspect of PMMA's biocompatibility is its ability to be modified to improve interaction with tissues. Recently, PMMA formulations have been developed that include antimicrobial additives and nanoparticles, thus increasing resistance to infections and contributing to overall oral health. These innovations enhance the biocompatibility of the material while providing additional protection against pathogens [7-9].

In addition, PMMA is compatible with other commonly used dental materials, such as metals and ceramics, allowing for complex hybrid restorations. This compatibility expands the applicability of PMMA in various dental procedures, reinforcing its essential role in modern dental practice [7-10].

PMMA biocompatibility also contributes to the ease of the process of adjusting and repairing dental restorations. Due to its excellent tissue tolerance, PMMA allows for quick and effective repairs without compromising the patient's oral health. This is especially important in the case of dentures and temporary restorations, where frequent adjustments are often required [8-10].

Durability

Durability is a critical aspect of materials used in dentistry, and PMMA (polymethyl methacrylate) is distinguished by its exceptional resistance to wear and fracture. This durability makes PMMA an ideal material for dental restorations, ensuring long-lasting performance and reliability in various dental applications. Its robust mechanical strength allows the use of PMMA in the making of crowns, bridges and dentures, where materials are subjected to continuous mechanical stress [11-13].

PMMA exhibits excellent dimensional stability, maintaining its shape and structural integrity over time. This is an essential feature for dentures and other restorations, which must withstand masticatory forces and thermal variations in the oral cavity. Its chemical stability also ensures resistance to chemical degradation, preventing damage to the material in acidic or alkaline environments [11-14].

PMMA's durability is also enhanced by its ability to be modified with additives that increase its strength. For example, the inclusion of zirconium oxide nanoparticles or glass fibers in PMMA formulations demonstrated a significant increase in fracture and wear resistance. These technological advances allow for the creation of dental restorations that offer a longer lifespan and superior performance [11-13].

Another factor that contributes to PMMA's durability is its impact resistance. This is crucial for dentures, which must withstand frequent manipulation and possible falls. PMMA is

able to absorb and distribute impact energy without fracturing, thus ensuring longer prosthesis life and increased patient safety [12-14].

Durabilitatea PMMA este, de asemenea, favorizată de proprietățile sale termice. Materialul prezintă o rezistență bună la variațiile de temperatură, ceea ce este esențial în mediul oral, unde temperaturile pot varia semnificativ. Această stabilitate termică contribuie la menținerea integrității restaurărilor dentare, prevenind deformarea sau deteriorarea lor în timp [11-14].

The mechanical properties of PMMA allow for dental restorations that are not only durable, but also easy to adjust and repair. This is an important feature for dentures and other restorations, where frequent adjustments and repairs may be necessary to maintain optimal comfort and functionality [12-14].

Aesthetics

Aesthetics play a crucial role in dentistry, as patients are looking for solutions that are not only functional but also improve their visual appearance. PMMA (polymethyl methacrylate) stands out for its ability to provide superior aesthetic results, being a preferred material for dental restorations. The natural transparency of PMMA allows for the accurate imitation of tooth enamel, providing an aesthetic solution that integrates harmoniously with natural teeth [14-16].

One of the main advantages of PMMA is the possibility of being colored to perfectly match the specific shade of the patient's teeth. This customization contributes to the creation of dental restorations that are almost indistinguishable from natural teeth, ensuring an impeccable aesthetic appearance. In the case of dental crowns and bridges, this level of customization is essential to achieve a pleasing and natural aesthetic smile [15-17].

PMMA allows for restorations with precise and fine edges, which improves the overall appearance of dental work and contributes to patient comfort. The ability to be shaped and polished to a high level of finish ensures a smooth, glossy surface that not only looks good, but is also easy to clean and maintain. It helps maintain oral health and prevents plaque buildup [15-16].

PMMA material is also versatile, being used in various types of aesthetic dental restorations, including veneers, crowns, and partial dentures. In the case of dental veneers, PMMA offers a temporary aesthetic option that allows patients to improve the appearance of their smile during orthodontic treatment or before permanent ceramic veneers are made [14-16].

PMMA allows for harmonious integration with other aesthetic dental materials such as composites and ceramics. This compatibility extends its applicability in various complex aesthetic treatments, ensuring superior results both aesthetically and functionally. PMMA is also often used to make dental mock-ups, allowing patients to visualize the final outcome of treatment before committing to definitive procedures [15-17].

PMMA's superior aesthetics are supported by its durability, which ensures that the aesthetic appearance is maintained in the long term. The material's resistance to discoloration and wear helps maintain an impeccable appearance of dental restorations for long periods. This is an important feature because patients want aesthetic solutions that will stand the test of time [14-17].

Recent innovations in PMMA formulations have enabled the development of materials with improved optical and mechanical properties. These advances have led to the creation of

dental restorations that offer an aesthetic even closer to that of natural teeth, while ensuring durability and increased comfort for the patient [16-18].

Applications of PMMA in dentistry

PMMA (polymethyl methacrylate) is widely used in dentistry due to its versatile properties, making it ideal for a variety of applications. One of the most common uses of PMMA is in making dentures. PMMA dentures are valued for their comfort, light weight, and ability to be easily adjusted to fit snugly into the patient's oral cavity. These prostheses offer an aesthetic and functional solution, restoring the chewing and speaking ability of edentulous patients [18-20].

Temporary dental crowns and bridges are other important applications of PMMA. Due to the ease with which it can be shaped and processed, PMMA is ideal for making these temporary restorations that protect the prepared tooth and maintain the aesthetics of the patient's smile until permanent restorations are made. PMMA allows the creation of crowns and bridges that are aesthetic, functional and provide adequate protection during the waiting period [19-21].

In orthodontics, PMMA is used to make clear braces and retainers. These devices are preferred by patients due to their discreet appearance and increased comfort. PMMA braces are almost invisible and offer an aesthetic solution for aligning teeth without compromising the aesthetic appearance of the smile during treatment [18-20].

PMMA is also used in maxillofacial surgery to make surgical guidelines and models for planning complex interventions. PMMA surgical guidelines help to perform precise interventions, reducing the risk of errors and improving clinical outcomes. PMMA models are used to visualize and plan facial reconstructions, ensuring a personalized and efficient approach [18-20].

In making temporary dental veneers, PMMA offers an aesthetic solution that allows patients to improve the appearance of their smile in the short term. PMMA veneers are used to test the shape, size, and shade of permanent veneers, giving patients the opportunity to express their preferences before final restorations are made [18-21].

PMMA is also used to make dental mock-ups, which allow patients to visualize the final result of the treatment before starting the final procedures. These mock-ups are essential for planning complex aesthetic treatments and for effective communication between the patient and the dentist [19-21].

Conclusions

PMMA continues to be a staple material in dentistry due to its outstanding biocompatibility, durability, and aesthetic properties. Recent advances in PMMA formulations have further improved the performance of this material, making it a modern and effective solution for durable dental restorations. Continued use and innovations in PMMA promise to bring significant benefits to both patients and dental professionals.

The exceptional biocompatibility of PMMA makes it an indispensable material in dentistry. Its ability to be well tolerated by oral tissues, combined with its chemical stability and versatility, ensures the long-term success of dental restorations. Continuous innovations in PMMA formulations promise to further improve these properties, reinforcing its position as a reference material in dentistry.

PMMA's exceptional durability makes it a staple material in dentistry. Its ability to resist wear, fractures and impact, combined with dimensional and chemical stability, ensures the long-lasting performance of dental restorations. Continuous innovations in PMMA formulations promise to further improve these properties, cementing its position as the preferred material for durable and effective dental restorations.

PMMA is an essential material in aesthetic dentistry due to its ability to provide superior and customizable visual results. Its transparency, versatility, and durability make PMMA a preferred choice for various dental restorations, helping to create aesthetic, natural, and long-lasting smiles. Continuous innovations in PMMA formulations promise to further improve these properties, reinforcing its role as a reference material in dental aesthetics.

PMMA is an extremely versatile material in dentistry, being used in a wide range of applications ranging from dentures and temporary crowns to surgical guides and temporary veneers. Its properties of biocompatibility, durability and superior aesthetics make PMMA a reference choice for numerous dental procedures, ensuring outstanding functional and aesthetic results. Continuous innovations in PMMA formulations promise to further expand the applicability and performance of this material, reinforcing its essential role in modern dental practice.

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