OPEN ACCESS

Saudi Journal of Oral and Dental Research
Abbreviated Key Title: Saudi J Oral Dent Res
ISSN 2518-1300 (Print) | ISSN 2518-1297 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

A Systematic Review to Understand the Association between Prosthetic Materials Used and its Biohazards

Balges Mohammad Alrowili*, Talal H. Bokhamsen, Fatima Sultana

Alslam Health Medical Hospital, Riyadh, Saudi Arabia

DOI: 10.36348/sjodr.2022.v07i01.008 | **Received:** 09.12.2021 | **Accepted:** 17.01.2022 | **Published:** 22.01.2022

***Corresponding author:** Balges Mohammad Alrowili
Alslam Health Medical Hospital, Riyadh, Saudi Arabia

Abstract

To integrate with the jawbone and gum tissues, a prosthetic dental material must be appealing, long-lasting, repairable, cleanable, and bio-compatible. In terms of new prosthetic materials, prosthodontics is rapidly evolving. Despite the fact that all artificial materials emit compounds into the oral environment, side effects and unpleasant responses are possible. We utilized Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to conduct an automated and manual search to find clinical studies that looked at the relationship between prosthetic materials and biohazards. A 'ideal' material will have properties that are equal to or very close to those of the material being replaced. One of the most important properties for any material used in the human body is biocompatibility, or more specifically bioactivity. Unlike other implanted materials, the biocompatibility of dental materials varies depending on their structure and state.

Keywords: Prosthetic materials, prosthodontics, biohazards, biocompatibility.

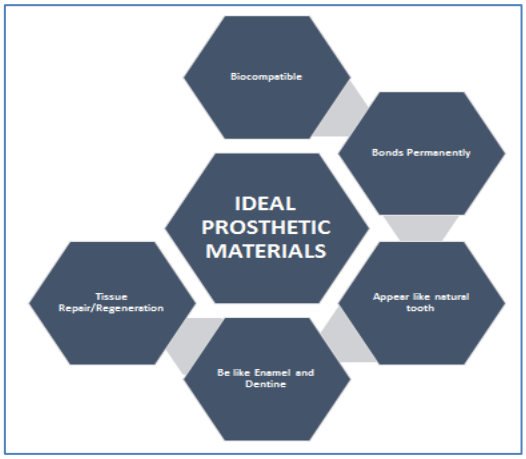
INTRODUCTION

Prosthodontics is the branch of dentistry which focuses on replacing missing teeth and soft and hard tissues with prosthetics (crowns, bridges, dentures), which can be fixed or removable or can be supported and retained by implants.

As a specialist dentist, a prosthodontist replaces missing teeth and related mouth or jaw structures with bridges, dentures, or prostheses. After dental school they receive three more years of specialized training. Prosthodontics encompasses many subspecialties including: Fixed; Removable; Maxillofacial and Implant prosthodontics [1].

Many factors contribute to tooth loss, including receding gums, bacteria, and infection, as well as natural tooth erosion. Many dental prosthetics solutions can be custom-designed to meet various needs. An ideal dental prosthetic should do more than simply replace missing teeth-it should also be functional. The material you choose for your prosthetic could impact your quality of life since you'll be chewing, talking, and smiling for an extended period of time [2].

A prosthetic dental material need to be attractive, long life, repairable, cleanable and bio-compatible to integrate with the jaw-bone and gum tissues. Prosthodontics is experiencing rapid growth in terms of new prosthetic materials. Prosthetic materials must adhere to a number of properties regarding biologic, physical, chemical, and aesthetic compatibility, which must be optimized in order to meet the increasing demands of patients.



Characteristics of an Ideal Prosthetic Material

The practice of prosthodontics involves working with materials of widely varying composition, including metals, resin-based synthetic polymers, cements, impression materials, and dental amalgam, composites, and ceramics. Such materials can leak and transfer potentially allergenic components, causing hypersensitive reactions among patients, dental personnel, and laboratory technicians [3].

Dental amalgam has in fact been debated for a long time with diversified opinions, but how safe are the materials used to replace it. A short-term and long-term reaction, no matter how severe or mild, should be documented widely so that due precautions can be taken. Mercury exposures have been reported from a variety of industries and from dental clinics with poor mercury handling practices.

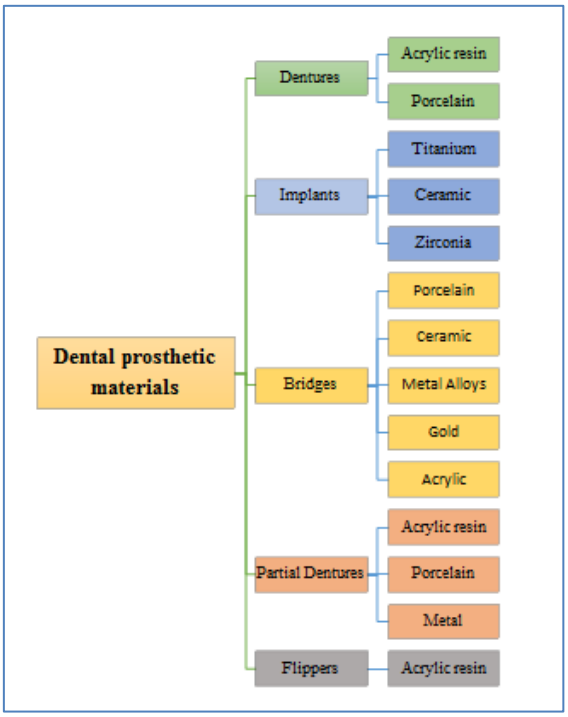
In dentistry, materials used are usually free of biological side effects. It is estimated that such adverse effects occur between 1:1000 and 1:10,000 of all dental treatments, depending on the type of practice and the materials utilized [4]. Despite the fact that all artificial materials release substances into the oral environment, there are some risks of side effects and adverse reactions.

There have been health concerns associated with amalgam, while different restorative materials have caused local oral effects. Dental restorative materials are being tested in a variety of environments to assess their biocompatibility. Researchers have studied the effect of resin constituents and filler particles on red blood cells (RBCs) and associated materials at both cellular and subcellular levels [5].

The side effects of prosthodontic materials can be caused by direct contact with soft or mineralized tissues or by exposure to leachable components caused by corrosion and degradation. The simultaneous and combined use of dental prosthetic restorations made of different alloys with different compositions will tend to worsen corrosion due to galvanic action. Ingestion of these materials may lead to local and systemic reactions [6].

A number of components used in prosthodontic materials can be allergic, toxic, and carcinogenic in specific situations. As an adverse effect, overhanging margins of restorations or an overextended denture may also cause local mechanical irritation. As a result, a number of potential problems may arise. In the literature, few side effects have been reported associated with prosthodontic materials. Furthermore, there have been no studies conducted to assess adverse effects [7].

A biological evaluation of prosthodontic materials is, therefore, challenging, and it is important to distinguish between potential and documented side effects. Prosthodontic materials need to be inert and insoluble, so it is important to keep this in mind [8]. As a result, toxic reactions are unlikely to occur since the amount of leachable components is small. A sensitized individual, however, only requires a small amount of an allergen to initiate an allergic reaction.



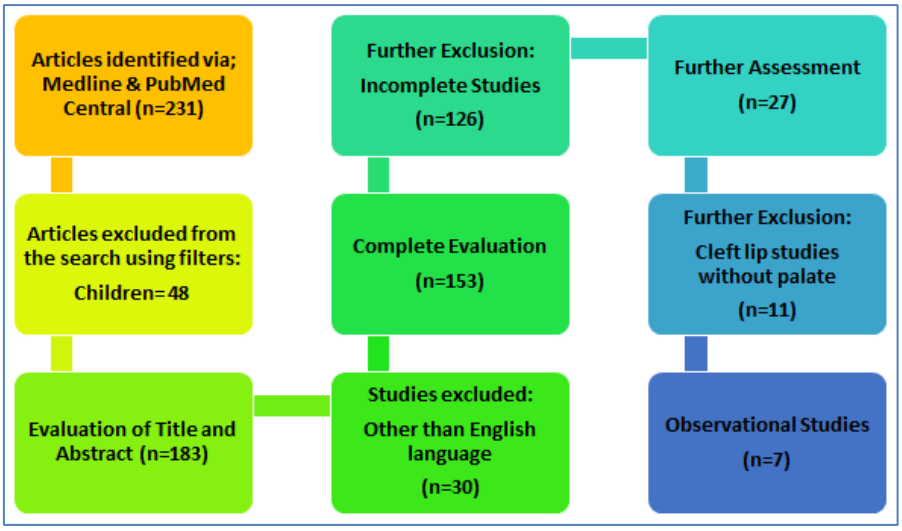
Graph-1: Graph showing different types of Prosthetic Dental materials

METHODOLOGY

We conducted an electronic and manual search using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to identify clinical studies featuring the association between prosthetic materials used and its biohazards. In this study, a systematic literature search was conducted using the Medline and PubMed Central databases in the English language on the effects of dental care during orthodontic treatment. We used an online data extraction form to extract data from online databases such as Medline and PubMed Central.

FILTERS

Prior to the screening, no filters were applied to the search, so that all studies can be screened for subsequent screening. As part of the exclusion criteria, Medline and PubMed Central added the following filters: human studies, English-language studies, and studies involving adults over 18 years old. This method of removing studies from original literature lists can be easily done.



Graph-2: Process of evaluation of articles related to the relationship between prosthetic materials used and its biohazards

Table-1: Different prosthetic materials used in dentistry

	PROSTHETIC MATERIAL	CHEMICAL NAME	INTRODUCTION IN DENTISTRY	PROPERTIES	USES IN DENTISTRY	BIOHAZARDS
1	Acrylic resin	Poly Methyl Methacrylate (PMMA)	1937	Durable, translucent, colorable, easy to process	Used in fabricating intra/extra oral prostheses, full denture base and gum work.	Respiratory reactions, transient redness, irritation, decreased tactile sensitivity, bleeding fissures, soreness, pain, gingival reactions, burning mouth syndrome, allergic reactions.
2	Gold	Aurum (Au)	2000 B.C	Longevity, durability, stability, immune to corrosion, mimcs hardness of natural teeth	Fillings, crowns, bridges	Redness, swelling, lip and mouth pain, gum swelling, irritation, lesions in mouth, allergic reactions.
3	Porcelain	Alumino Silicate Matrix	1950	High in strength, stiffness, low densities, low wear, increased chemical resistance.	Esthetics, implant abutments, implants.	Parafunction, bruxism, clenching, immature teeth, supra gingival teeth.
4	Titanium	Titanium (Ti)	1947	Pseudo elasticity, hysteresis, dissipation, biocompatible, corrosion resistant, versatile, utile, castability	Dental implants, frameworks, crowns, bridge, fixed and removable prosthesis.	Erythema, urticarial, eczema, swelling, pain, necrosis, bone loss.
5	Zirconia	Zirconium Dioxide	1990	Highly biocompatible, lower toxicity, high flexural strength, high fracture toughness.	Full veneer crowns, partial veneer, resin bonded fixed partial dentures	Localized gingival irritation, post-operative tooth sensitivity.
6	Metal Alloys	stainless steels, nickel-chromium, cobalt-chromium, titanium, and nickel-titanium alloys	19th century	Light in weight, better mechanical properties, corrosion resistance, less expensive	Dental implants, crowns, bridges, inlays, onlays, bar correctors.	Stomatitis, oral lichenoid reactions, dryness of mouth, metallic mouth, hypersensitivity.

RESULTS

Acrylic resin chemically known as Poly Methyl Methacrylate (PMMA) was first used in dentistry as a prosthetic material in 1937, It is known for its characteristics like: Durability, translucency, colorability, and is easy to process. Its used in fabricating intra/extra oral prostheses, full denture base

and gum work. Several adverse biohazards reported are: Respiratory reactions, transient redness, irritation, decreased tactile sensitivity, bleeding fissures, soreness, pain, gingival reactions, burning mouth syndrome, allergic reactions. Another prosthetic material used since 2000 B.C is Gold, chemically called as Aurum (Au) and has properties like: Longevity, durability, stability, immune to corrosion, mimics hardness of natural teeth used as Fillings, crowns, bridges causes few biohazards like: Redness, swelling, lip and mouth pain, gum swelling, irritation, lesions in mouth, allergic reactions. Porcelain is the prosthetic material, chemically known as Alumino Silicate Matrix 1950 High in strength, stiffness, low densities, low wear, increased chemical resistance. It is used in Esthetics, implant abutments, implants in dentistry. It is known to cause some biohazards: Parafunction, bruxism, clenching, immature teeth, supra gingival teeth. Titanium chemically known as Titanium (Ti) was firstly used in 1947 shows characteristics features like: Pseudo elasticity, hysteresis, dissipation, biocompatible, corrosion resistant, versatile, utile, castability and hence used in Dental implants, frameworks, crowns, bridge, fixed and removable prosthesis. Titanium causes Erythema, urticarial, eczema, swelling, pain, necrosis, bone loss. Zirconia also known as Zirconium Dioxide was used in1990 is highly biocompatible, lower toxicity, high flexural strength, and high fracture toughness. Zirconia is used in Full veneer crowns, partial veneer, resin bonded fixed partial dentures. It has some biohazards like Localized gingival irritation, post-operative tooth sensitivity. The Metal Alloys like stainless steels, nickel-chromium, cobalt-chromium, titanium, and nickel-titanium alloys was used firstly in 19th century is Light in weight, has better mechanical properties, corrosion resistance, less expensive and hence used as Dental implants, crowns, bridges, inlays, onlays, bar correctors. Different metal alloys cause Stomatitis, oral lichenoid reactions, dryness of mouth, metallic mouth, and hypersensitivity.

DISCUSSION

Prosthodontic materials may have unexpected biological side effects as a result of direct contact with soft or mineralized tissues, or exposure to leachable components as a result of corrosion and degradation products. The presence of multiple dental prosthesis restorations composed of different alloys with different compositions will tend to increase the corrosion induced by galvanic activity [9]. Because these components may be indigestible, they may cause local and systemic responses. Components of prosthodontic materials and their corrosion/degradation products have been shown to be allergenic, poisonous, and carcinogenic in some circumstances [10]. Local mechanical discomfort caused by an overhanging repair margin or an overextended denture must be regarded as well. As a result, there are a number of potential issues [11].

Nevertheless, there have been few reports of prosthodontic material negative effects in the literature. Similarly, no comprehensive studies have been conducted to determine the frequency of harmful effects. As a result, assessing biological side effects of prosthodontic materials is difficult, and it's critical to distinguish between possible and documented side effects [12]. It's important to keep in mind that prosthodontic materials are designed to be inert and insoluble. As a result, the levels of leachable components are low, making hazardous reactions improbable. In a sensitized individual, however, low levels of the allergen are required to initiate an allergic reaction. The most prevalent side effects of prosthodontic materials are contact allergy reactions [13].

According to the literature, allergic reactions to gold-based restorations are more common than allergic reactions to nickel-containing alloys. The most prevalent clinical signs were gingivitis and stomatitis, while nearly a quarter of the patients had distant reactions. Mucosal reactions to metal-based partial dentures, on the other hand, are uncommon. The most common gingival indications and symptoms might be attributed to direct pressure contact and the resulting trauma, rather than to side effects of the alloys or materials utilized in the production of the Removable Partial Denture RPD. Biological reactions to casting alloys are reliant on the release of components from the alloys, implying that they should be avoided [14].

However, there appears to be no link between mucosal reactions to fixed prosthetics and corrosion or tarnish. This discrepancy could indicate that the biological reactions observed are due to reasons other than the substance itself [15]. Palladium alloys are often better tolerated for metal-ceramic restorations than base-metal alloys or gold alloys, albeit they tarnish more quickly than other casting alloys. Technicians who often braze metals above their melting point, on the other hand, are at risk because cadmium evaporates during soldering and welding. This poses a difficulty in terms of the need for a sufficient fume extraction system to be available. Cadmium-containing solders have also been substantially phased out as a result of this hazard. Alloys are one of the materials used in the construction of creating traditional cast posts and cores Stainless steel pins are sometimes used with a number of metal combinations. When creating post retained crowns, it's especially important to avoid using two different alloys for the post and cast core/crown at the same time since galvanic corrosion might induce root fractures [16].

Dental composites, resins, and implants are just a few of the materials used in dentistry. The physiochemical qualities of dental materials, as well as their biological and toxicological dependability, are essential for their successful clinical application. Dental

materials have been linked to a variety of local and systemic toxicity issues. If these materials are left in the mouth for an extended period of time, they may cause adverse effects. Filling materials, restorative materials, intracanal medications, prosthetic materials, various types of implants, liners, and irrigants are only a few of the materials used in dentistry. The growing rate of creation of novel materials with uses in dentistry has raised awareness of the biological dangers and tempting limitations of these materials.

It is critical to employ healthy and secure components in dental procedures. In dentistry, the use of various materials in long-term oral usage necessitates the use of low or harmless agents for both patients and staff. Furthermore, screening tests should be used to assess any potential harm before being used in clinical trials.

There are numerous potential issues, however just a few documented adverse reactions have been published. Nickel is a severe allergy, a carcinogen, and can be disseminated to many organs in experimental investigations in animals; therefore the presence of nickel has gotten a lot of attention. Clinicians and producers are expected to be required to report biological side effects related with the use of the materials to certifying bodies or health authorities. This will meet the needs of patients and those handling the products due to the low occurrence of detrimental reactions of the materials already in use. To clarify the different safety issues and incidence of potential complications in general dentistry, including dental implants, reliable research information based on sound methodology is required.

CONCLUSION

Chemically and physiologically reactive biomaterials are commonly employed in dentistry. Patients getting dental treatment may be exposed to a variety of allergies, but serious reactions appear to be uncommon. Stomatitis, burning, tingling, cheilitis, oral lichenoid lesions, lip and face swelling, and other symptoms or signs may be linked to dental treatment or the use of dental goods. The qualities of a 'ideal' material will equal or be extremely near to those of the material being replaced. Biocompatibility, or more specifically bioactivity, is one of the most crucial characteristics for any material utilized within the human body. Unlike other implanted materials, a dental material's biocompatibility varies depending on its form and state. Unmixed materials can elicit a moderate allergic reaction, whereas loaded materials are usually biologically inert.

REFERENCES

1. Jacobsen, N., & Hensten-Pettersen, A. (1989). Occupational health problems and adverse patient reactions in orthodontics. *The European Journal of Orthodontics*, *11*(3), 254-264.
2. KALLUS, T., & MJÖR, I. A. (1991). Incidence of adverse effects of dental materials. *European Journal of Oral Sciences*, *99*(3), 236-240.
3. Mackert, J. R. (1992). Side-effects of dental ceramics. *Advances in dental research*, *6*(1), 90-93.
4. Hensten-Pettersen, A. (1992). Casting alloys: side-effects. *Advances in dental research*, *6*(1), 38-43.
5. Espelid, I., Tveit, A. B., Tornes, K. H., & Alvheim, H. (1999). Clinical behaviour of glass ionomer restorations in primary teeth. *Journal of dentistry*, *27*(6), 437-442.
6. Melchart, D., Vogt, S., Köhler, W., Streng, A., Weidenhammer, W., Kremers, L., ... & Halbach, S. (2008). Treatment of health complaints attributed to amalgam. *Journal of dental research*, *87*(4), 349-353.
7. Mjör, I. A. (1992). Problems and benefits associated with restorative materials: side-effects and long-term cost. *Advances in dental research*, *6*(1), 7-16.
8. Tillberg, A., Järvholm, B., & Berglund, A. (2008). Risks with dental materials. *Dental materials*, *24*(7), 940-943.
9. Mjör, I. A., & Christensen, G. J. (1993). Assessment of local side effects of casting alloys. *Quintessence international*, *24*(5).
10. Carmichael, A. J., Gibson, J. J., & Walls, A. W. (1997). Allergic contact dermatitis to bisphenol-A-glycidyldimethacrylate (BIS-GMA) dental resin associated with sensitivity to epoxy resin. *British dental journal*, *183*(8), 297-298.
11. Mortz, C. G., Lauritsen, J. M., Bindslev-Jensen, C., & Andersen, K. E. (2002). Nickel sensitization in adolescents and association with ear piercing, use of dental braces and hand eczema. *Acta dermato-venereologica*, *82*(5), 359-364.
12. Katoh, N., Hirano, S., Kishimoto, S., & Yasuno, H. (1999). Dermal contact dermatitis caused by allergy to palladium. *Contact Dermatitis*, *40*(4), 226-227.
13. Trombelli, L., Virgili, A., Corazza, M., & Lucci, R. (1992). Systemic contact dermatitis from an orthodontic appliance. *Contact Dermatitis*, *27*(4), 259-260.
14. Agarwal, S., & Gawkrodger, D. J. (2002). Latex allergy: a health care problem of epidemic proportions. *European Journal of Dermatology*, *12*(4), 311-5.
15. Berkun, Y., Ben-Zvi, A., Levy, Y., Galili, D., & Shalit, M. (2003). Evaluation of adverse reactions to local anesthetics: experience with 236 patients. *Annals of Allergy, Asthma & Immunology*, *91*(4), 342-345.
16. Lygre, H. (2002). Prosthodontic biomaterials and adverse reactions: a critical review of the clinical and research literature. *Acta Odontologica Scandinavica*, *60*(1), 1-9.