

Dental Materials and Their Impact on Oral Health: Insights and Implications

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ABSTRACT

Dental materials are commonly used in dentistry to treat dental issues and restore the normal function and appearance of teeth. Although these materials are beneficial, they can sometimes cause adverse effects in the mouth. These effects may involve both the hard tissues, like teeth, and the soft tissues, such as the gums and tongue. Common reactions include geographic tongue, recurrent aphthous ulcers, contact stomatitis, and amalgam tattoos. In some cases, dental materials can also lead to tooth discoloration, especially when the restoration fails or leaks. If the restorative material does not properly seal the tooth, it may affect the dental pulp, leading to inflammation or even pulp necrosis.

Furthermore, understanding how dental materials such as metals, ceramics, and composites are classified is important because it helps determine how they interact with oral tissues and the potential problems they may cause. Another key factor is biocompatibility, which ensures that dental materials do not harm the tissues in the mouth. This highlights the need to select safe materials to prevent unwanted reactions. This review explores the relationship between dental materials and common oral health issues, and emphasizes the importance of using biocompatible materials to reduce side effects and improve patient outcomes.

Keywords

Bioactive, Tissue Regeneration, Remineralization, Biocompatibility, Dental Material, Amalgam Tattoo, Tooth Staining, Pulpal Reaction

INTRODUCTION

Dental materials can be categorized in several ways. They can be grouped into different classes. The duration of use determines whether dental materials are classified as temporary or permanent. Temporary materials, usually used for a short time, support tissue repair. Permanent materials should last as long as possible and are typically used to replace or restore tissue function ¹.

A biomaterial consistently interacts with the biological environment when it encounters

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bodily fluids and tissues. This interaction is central to biocompatibility, defined as the capacity of a dental biomaterial to interact favorably with the biological environment and inflammatory response without causing harm or ongoing inflammation at the contact point or nearby areas, e.g., saliva, blood, gingival tissues, and bone ². A material that does not cause harm in the biological environment may be considered biocompatible ^{2,3}. The term “appropriate host response” generally means there is no adverse reaction from the living system to the presence of such a substance, since the primary goal of most dental materials is achieved through their physical or mechanical properties ⁴. Importantly, this interaction is complex, dynamic, and mutual, meaning the material can influence the biological environment just as the environment can affect the material. The complexity of this relationship is evident in reactions that can occur at distant sites or at contact points. Symptoms such as skin irritation, joint issues, or neurological problems may not always indicate a connection to the biomaterial. These interactions and potential risks are considerable for both patients and dental staff ⁵.

In certain situations, dental personnel are more likely than patients experiences adverse impacts to biomaterials. Dental professionals are the primary group affected by adverse reactions to dental resins, especially acrylics and rubber materials. Hand and fingertip symptoms such as itching, irritation, swelling, dryness, cracking, and flaking of the skin have been reported ⁶. Recently, the use of resin-based restorative materials in dentistry has grown owing to several factors, including their ability to closely mimic the natural appearance of teeth, reduced need to remove healthy tooth structure, improved strength and durability, and their capacity to bond directly to the tooth. They are also more biocompatible, cause less post-treatment sensitivity, and benefit from technological advances, making them easier and more reliable to use. There are concerns about the potential harmful effects of mercury in amalgam fillings. Components of dental composite resins have been shown to dissociate from the materials ⁷. Unpolymerized monomers can potentially cause adverse reactions if they leak into saliva ⁸.

Problem statement of this paper

Dental restorations, prostheses, orthodontics, and surgery all rely heavily on range of materials. These

materials are designed to function within the mouth’s delicate, dynamic environment. However, not all dental materials are inert; some, whether due to their composition, breakdown products, or microbial colonization, may trigger systemic or localized responses. Chronic inflammation, pigmentation, allergic reactions, and pulp necrosis are among the issues that can arise. The frequency of material-induced oral lesions underscores the need for greater knowledge and awareness among healthcare providers, despite advances in dental materials science. By linking clinical outcomes to specific materials and their biological effects, this review seeks to clarify these concerns.

Objectives of this narrative review

This review examines the impact of dental materials on oral health. While essential for restoring function and appearance, these materials also come into direct contact with oral tissues, potentially causing adverse effects. The paper aims to categorize commonly used dental materials in clinical dentistry, examine the biological responses they elicit at local and systemic levels, and discuss clinical issues such as amalgam tattoos, contact stomatitis, geographic tongue lesions, and recurrent aphthous stomatitis associated with dental material exposure. It also assesses how dental materials interact with tooth pulp, evaluates their biocompatibility, and guides clinicians in selecting safe and effective dental materials.

MATERIALS AND METHODS

This review was conducted through a wide-ranging literature search of digital archives, including Google, Google Scholar, PubMed, Science Direct, Scopus, Web of Science, and ResearchGate. The following keywords were used: dental materials, biocompatibility, amalgam tattoo, contact stomatitis, geographic tongue, recurrent aphthous stomatitis, and pulpal reaction. To provide a comprehensive overview, bench-to-bedside research, case reports, systematic reviews, and meta-analyses were included. High-quality research with clear methods and meaningful results was given top priority. The data were summarized thematically, focusing on material categorization, clinical symptoms, histological responses, and current best-practice guidelines. The flowchart in [Figure 1](#) illustrates the materials and methods used in this narrative review.

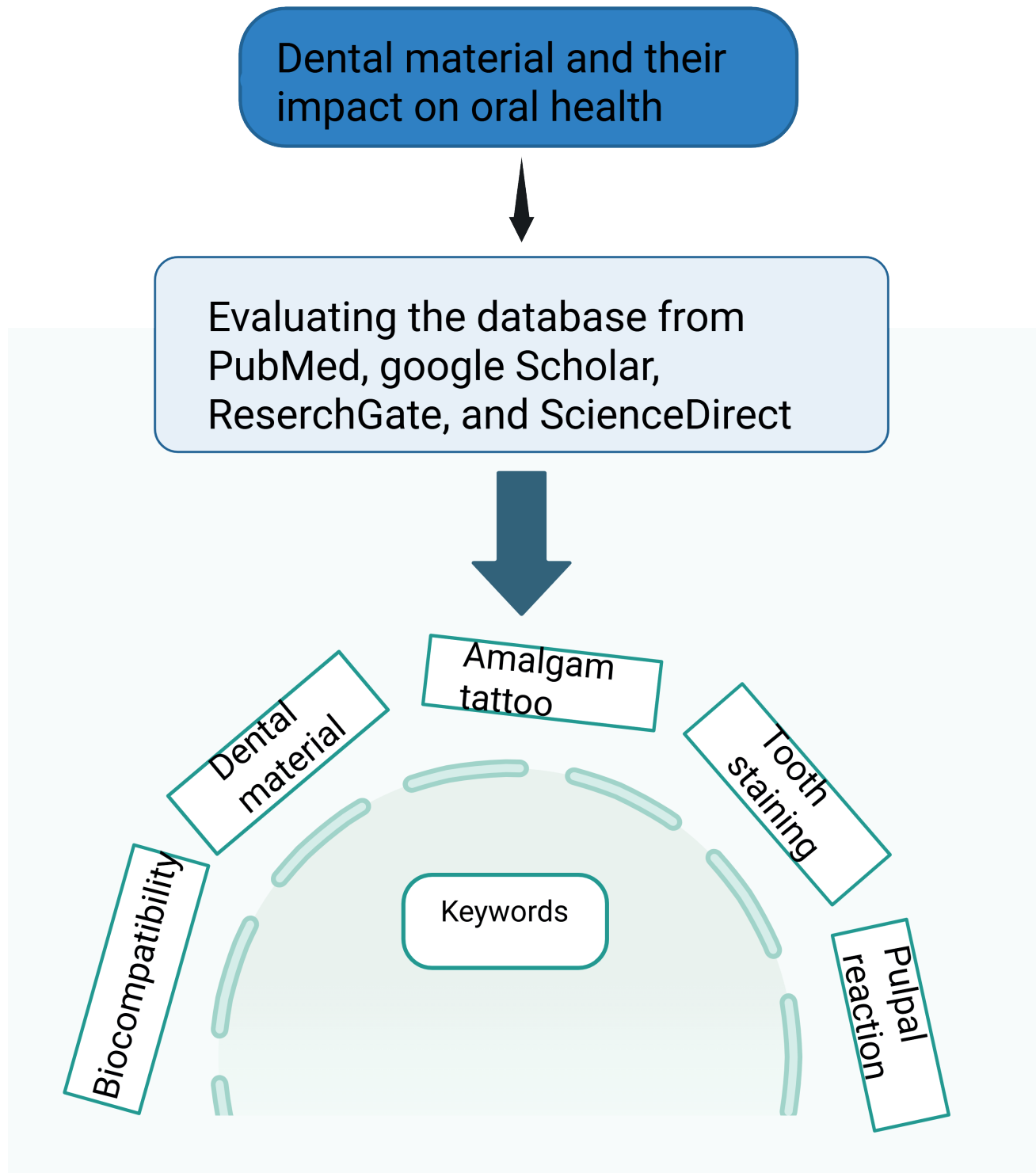


Figure 1: Diagram illustrating the study's methodology.

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Table 1: Categorization of dental invigorating constituents ¹⁰.

Category		Material
Restorative		
Metallic	Direct	Silver-based amalgam. Gold Foil Restoration.
	Indirect	Cast restoration-noble. Metal, base metal
Nonmetallic (tooth-colored restoration)	Direct	Glass Ionomer Cement (GIC). Composite resin.
	Indirect	Dental ceramics. Indirect composite.
Auxiliary (depending on application)	Pulp protection materials	Dental varnish (cavity sealer), Liner (Ca(OH) ₂ , zinc oxide-eugenol (ZOE), Base (thermo-mechanical Insulator)-Zn ²⁺ (PO ₄) ₂ , GIC, Zn ²⁺ O ²⁻ -polyacrylic acid cement.
	Adhesive	Phosphoric acid etchant, Dental Adhesive [Etch and Rinse (E&R), Self-etching primer (6th or 7th Generation Adhesive), universal]
	Luting	GIC, Zn ²⁺ (PO ₄) ₂ , Resin-based cement
	Impression material	Inelastic or rigid, elastic agar-based impression material and elastomeric impression materials.
Cements	Zinc based	Zn ²⁺ O ²⁻ eugenol, Zn ²⁺ (PO ₄) ₂ , and Zn ²⁺ polyacrylate.
	Silicate based	Silicate, GIC
	Calcium and calcium silicate Based	Ca(OH) ₂ , mineral trioxide aggregate (MTA), Bioactive Dentin Substitute
Laboratory material	Gypsum	Type I to Type V [based on American National Standards Institute / American Dental Association (ANSI/ADA) requirement]
	Dental wax	Modeling Wax, pattern wax, baseplate processing wax-Boxing wax (or peripheral Wax), dental sticky waxes, inelastic or rigid impression material impression (corrective wax), bite registration wax
Investment materials		Gypsum-bonded, phosphate-bonded, and ethyl silicate-bonded
Casting materials		Spruce (professional cleaning or prophylaxis, ceramic fiber liner.

Review of Literatures

Classification of dental material

The classification of the material's adverse effects is examined at both the clinical and cellular levels (Table 1) ¹⁰. Numerous studies have been conducted for better understand and improve the mechanical and physical properties of dental materials. When selecting a material for dental use, it is important to consider both physical and mechanical properties. However, biological factors must also be considered.

All ingredients used in the cavitas oris must be safe for soft tissues and the pulp. They should also be free of hazardous substances that could enter the bloodstream and cause systemic toxic reactions. Any potential sensitizers that could trigger allergic reactions should be removed from the material. Additionally, the material should not be carcinogenic ¹¹. Components known to cause allergies, sensitivities, or health risks—such as nickel in metal alloys or mercury in fillings—will be discussed in the following sections. This is important because some individuals may react adversely to these chemicals, and awareness can help in choosing a safer alternative ¹².

Adverse Effects on the Oral Mucosa from a Clinical Perspective

Amalgam markings are among the most common melanocytic abnormalities in the oral epithelium. An amalgam tattoo, also called amalgam pigmentation, is a benign condition that can occur in the mouth (Figure 2) ¹³. It results from tiny dental amalgam particles depositing in the soft tissues of the mouth, causing a specific type of pigmentation ¹⁴. The main components of dental alloys are copper, silver, palladium, and gold. Silver can enter the oral environment through amalgam and silver alloy prosthetics ¹⁵. Several factors, including dental procedures such as the insertion, removal, or replacement of amalgam fillings, can cause soluble silver compounds to migrate to and deposit in soft tissues ¹⁶.

Additionally, amalgam particles containing silver, tin, and mercury can accumulate in oral tissues. Amalgam particle deposition may also occur following trauma to the oral tissues, such as accidental injury or surgical procedures ¹⁷. Amalgam tattoo lesions appear as one or more small, soft, chronic, asymptomatic, persistent spots that may occasionally enlarge. There is no

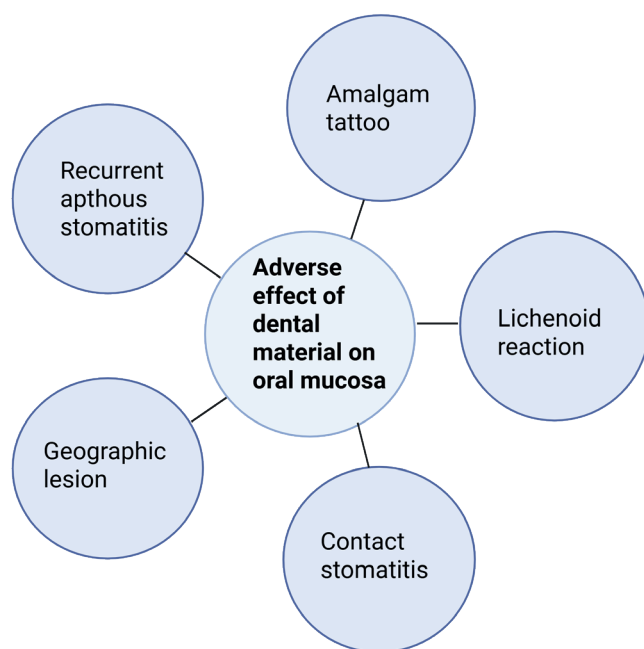


Figure 2: Adverse consequences of dental supplies on the epithelial layer of the mouth cavity.

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surrounding erythema. The macular, bluish-gray, or even hyperpigmented patches are usually located on the palatal surface, gingival tissues, or oral epithelial lining ¹⁸.

An amalgam tattoo's radiographic image can show a radiopaque area in the soft tissues of the mouth. In some cases, this radiopaque area may be clearly visible and easy to identify ¹⁹. To confirm the presence of amalgam particles in the connective tissue, a biopsy should be performed if there is uncertainty, such as when melanin pigmentation is unclear ^{13,20}. Amalgam tattoo lesions appear under a microscope as large, fine, solid, dark brown, or coarse-grained beads. These beads are often located in the subepithelial (submucosal) connective tissue, which contains blood vessels, nerve sheaths, basement membranes, and collagen bundles ^{19,21}.

In most cases, amalgam tattoos do not require treatment. Treatment may be considered if there are cosmetic concerns, especially if the tattoo is on the lips or the front of gums. Taking into consideration the size, location, and complexity of the lesion, different

methods can be used. Surgery is rarely needed and is usually reserved for large or persistent tattoos. Laser therapy offers a faster, less invasive option by breaking down the pigment with laser light. It can also help the area heal more quickly and with less discomfort than traditional surgical methods. ²³

Lichenoid reactions in the mouth can be caused by metals, amalgam, resins, and other dental restorative materials, and they often have a distinctive appearance ²⁴. Studies suggest that these reactions are often type IV delayed hypersensitivity reactions. In many cases, mercury from amalgam fillings is suspected to be the cause of these oral lichenoid reactions ²⁵⁻²⁷. Oral lichenoid lesions (OLL) are eruptions in the oral cavity with a specific origin that resemble oral lichen planus (OLP) both histologically and clinically ²⁸⁻³⁰. OLP is a chronic T-cell-mediated autoimmune disease affecting the oral mucosa. OLL has a similar appearance and is frequently associated with external factors, including contact allergic eczema (type IV hypersensitivity or cell-mediated immune reaction) to dental materials such as amalgam ^{31,32}.

The striated, reticular, plaque-like, erythematous (atrophic), erosive, blister-like (papulovesicular), and desquamative lesions are among the types of OLLs triggered by immune-mediated (hypersensitivity-driven) states. Patients report experiencing pain, itching, a metallic or battery-like taste, or soreness ³³. Other clinical signs of oral contact hypersensitivity include burning, pain, dry mouth, and the distinctive lichenoid features of the tongue, lips, and mucosa of the mouth cavity ^{34,35}.

First, the preliminary evaluation was confirmed by the patient's history, clinical examination, and comprehensive testing, including cutaneous patch testing, direct and, indirect immunofluorescence, and histopathological analysis ³⁶⁻³⁸. Pharmaceutical treatment is unnecessary for asymptomatic ³³, non-ulcerative OLP lesions, and follow-up is recommended when treating symptomatic but non-ulcerative areas of OLP ^{33,39}. Benzylamine hydrochloride (0.15%) is suggested as a topical anesthetic for symptomatic pharmacological treatment of OLP ⁴⁰. Tantum Verde's active ingredient, Benzylamine Hydrochloride, can also be used as an oral rinse, liquid, or spray for topical treatment ^{41,42}. Depending on the severity of the lesions, an adult should rinse their mouth 3 or 4 times a day with at least 15 mL (1 tablespoon) ³³.

Contact stomatitis (Figure 2) is inflammation or discomfort of the oral mucosa caused by external stimuli (e.g., chemical agents, heat, dentures) or by allergens (e.g., flavoring agents, toothpaste) ⁴³. It features skin lesions that may develop with persistent exposure to irritating substances on the oral mucosa. Contact allergy occurs when the skin or mucous membranes react to a specific chemical after repeated exposure ^{44,45}. This reaction is an inflammatory response that often appears as a painful or irritated area where a chemical comes into direct contact with oral tissue. It is often triggered by haptens, which are small molecules that aren't harmful on their own but can induce an immune response when they bind to proteins in the body. Langerhans cells, immune cells located in the skin and oral mucosa, initiate the reaction by processing the hapten and converting it into an active antigen. ^{46,47} Once this antigen forms, T cells in the immune system become sensitized and promote the production of IgE antibodies specific to the chemical antigen ⁴⁸. Reactive, or susceptible, individuals exhibit an inflammatory response localized to the contact site upon re-exposure to the antigen ⁴⁵. However, this condition is less common than contact cheilitis or contact allergic dermatitis, probably because the mouth is constantly rinsed with saliva, which dilutes substances and shortens their contact time with the mucosa. Any substance absorbed through the mucosa is quickly eliminated because the lining of the mouth has a rich blood supply. Since the oral lining is not heavily keratinized, chemicals are less likely to bind to keratin proteins and trigger an allergic reaction ⁴⁹⁻⁵¹.

Contact with meals, dental restorative biomaterials, or oral hygiene products can lead to contact stomatitis ⁵². Cinnamon and peppermint, often used as flavorants in food, candies, and bubblegum, as well as, in dental care products, such as dentifrices, (dental cream or gel), oral rinse, and dental thread, tape, or yarn, are common sources of contact oral reactions ^{50,53-58}.

Dental materials such as nickel in orthodontic wires, free monomer in acrylics, gold in crowns, and mercury in amalgam are all associated with contact allergic stomatitis ^{59,60}. Some users of tartar-control toothpaste have a higher likelihood of experiencing superficial mucosal peeling due to pyrophosphates and Zn²⁺ citrate; however, this reaction is considered a physical discomfort caused by chemical irritation, known as an "irritant contact reaction." ^{6,61,62}.

Geographic lesions (Figure 2) include geographic stomatitis, a rare, migratory, benign oral mucosal condition of unknown etiology ^{63,64}. Erythema migrans, annular migrans, migratory mucositis, and ectopic geographic tongue are all synonyms for this disease ^{64,65}. It is typically harmless, presents with no symptoms, and the lesion appears on the dorsolateral surface of the tongue, affecting men and women equally ⁶⁶. Determining the exact prevalence of this disorder is difficult because most patients do not exhibit these lesions and may not be aware that they are present in the oral cavity ^{66,67}. However, it was noted that 1-2.5% of the general population and up to 14.3% of pediatric cases have the aforementioned disease ^{65,66}. The tongue, buccal mucosa, lower labial mucosa, mucobuccal fold, vestibule, floor of the mouth, lips, and soft palate are the most commonly affected areas in geographic stomatitis. It causes rose-colored erythematous oral mucosal lesions that change shape, size, or location over hours or days, often encircled by an icy, ashen, or creamy color perimeter ^{63,64}.

Geographic stomatitis and tongue histopathologic features include parakeratosis, Munro's microabscesses, elongated and edematous papillae, and enlarged rete ridges ^{68,69}. Although these conditions usually remain symptom-free, Goregen et al. (2010) reported that 24.1% of patients with oral burning had geographic tongue as a contributing factor ⁷⁰. Informing patients that this lesion is benign, non-cancerous, and self-limiting is usually sufficient; most patients do not need treatment, especially if the lesion remains asymptomatic ⁶⁸. Conversely, this approach depends on a careful and accurate medical assessment ^{63,68}. The severity of symptoms determines whether therapeutic intervention is necessary ⁶³. The preferred treatments include steroids, anxiolytics, topical analgesics, and antihistamines. Topical tacrolimus and vitamin A are also recommended as effective options for this lesion ^{70,71}.

Recurrent aphthous stomatitis (RAS) is a chronic inflammatory condition that affects the oral mucosa ⁷². The confusing oral condition known as RAS, or "canker sores," ^{73,74} is characterized by the frequent appearance of painful aphthous ulcers on non-keratinized oral mucous membranes ^{73,74}. The unclear origin of RAS makes this disorder a significant challenge for both patients and healthcare providers, as it is considered a multifactorial, T-cell-mediated immune-dysregulated disease. RAS affects up to 25% of the population, and there is no definitive cure ⁷⁵. About one in four people

develop RAS, which currently has no known cure. Medical professionals suggest that RAS can result from various causes. The main factors include immune system problems, low blood cell counts, and family history, with genetics being the best-known cause^{76,77}.

Additionally, some studies indicate that certain toothpaste chemicals, such as sodium lauryl sulfate (SLS), may cause similar mouth ulcers in sensitive individuals⁷⁸. However, a recent double-blind, crossover study showed that toothpaste without SLS had no noticeable effect on ulcer formation^{79,80}. Canker sores almost always develop on soft, loose tissues such as the tongue, the floor of the mouth, the soft palate, and the inside of the lip or cheek. The initial symptoms usually include pain or a burning sensation, often triggered by stress, minor injury, or specific foods, followed by tingling or burning 1 to 2 days later⁸¹. In severe cases, symptoms may include fever, swollen lymph nodes in the neck, and fatigue. A dental surgeon can identify recurrent aphthous stomatitis by its appearance and pain. Treatments include pain relievers, mouthwashes, and oral corticosteroids^{82,83}.

Adverse Effects on Teeth

Many factors, including the types of materials used in restorative dentistry, how these materials interact with the oral environment, and patient habits, can cause dental stains related to dental materials. Common causes include leakage from amalgam (black-gray), surface degradation of resin composites, and staining of porous glass ionomers^{84,85}. In most cases, intrinsic discoloration results from dental restorations⁸⁶. Composites, glass ionomer, and acrylic restorations can cause the tooth adjacent to the material to become progressively gray^{87,88}. Eugenol, root canal sealants, and polyantimicrobial pastes are additional dental products that may lead to intrinsic discoloration. Dental restorative materials, particularly amalgam restorations, contain silver sulfide, which appears as a grayish-black stain that can reflect through the enamel, leading to tooth discoloration⁸⁹. Younger patients with more open dentinal tubules are more likely to experience staining of the tooth. Composite fillings have pharmacodynamic properties that can cause staining over time, even though they are meant to match the color of natural teeth and are highly porous; these materials can absorb stains from smoke, food, and drinks like coffee and tea⁹⁰⁻⁹³. Additionally, the labial surface may exhibit noticeable grayish discoloration, and deep lingual metallic

restorations on anterior incisors can cause significant staining of the underlying dentin. The dental surgeon should avoid using amalgam to repair anterior teeth that have undergone endodontic treatment to minimize complications and discoloration^{17,94-98}.

Dental restorative products are generally biocompatible; therefore, the pulp's response or reaction to these orthodontic consumables is not very common^{99,100}. However, some of these materials contain substances that could be harmful or irritating¹⁰¹. Additionally, the pulp may suffer adverse effects from chemical reactions that occur during the setting or hardening process of the materials. Therefore, the dental pulp can experience various types of damage before, during, and after the restoration of a decayed tooth^{102,103}.

In conclusion, the dental pulp can be affected by various factors during and after cavity preparation. Heat and drying of the tooth, if not properly controlled, may damage the pulp^{104,105}. Similarly, the pressure applied during placement of materials like gold or amalgam, or the hydraulic forces used during procedures such as crown placement, can also cause stress or trauma to the pulp tissue^{106,107}. Many dental materials release harmful chemical substances, especially during the setting process^{108,109}. These substances can directly affect pulp cells, causing irritation or damage¹¹⁰. In fact, almost all restorative materials emit certain molecules when first placed into the tooth. These molecules can easily pass through the dentin to reach the pulp, where they may trigger harmful reactions¹¹¹⁻¹¹³.

In a vital tooth, dentinal fluid flows from the pulp to its outer layer and the restoration. This movement might affect the material, gradually weakening it over time. If the repair is placed directly on an exposed pulp, excess moisture could cause hazardous substances to be released^{114,115}. The thickness of the remaining dentin is critical because it determines how many chemicals can reach the pulp. Thin dentin provides less protection, exposing the pulp. After filling, some sensitivity may occur due to galvanic effects or sudden temperature changes¹¹⁶⁻¹¹⁹. Bacteria may also penetrate between the tooth and the restoration, leading to pulp inflammation or even secondary issues, such as cavities^{102,120,121}.

Dental societies have developed numerous tests to evaluate whether dental materials are safe or potentially hazardous^{111, 122, 123}. Different tests help understand how various materials interact within the body¹²⁴. This framework, "ISO 7405 (Evaluation of Biocompatibility

of Medical Devices Used in Dentistry”¹²⁵ provides dependable guidance on how to ensure a material’s safety for use in the oral cavity while maintaining the necessary mechanical properties. This method enables dentists to choose materials that are both safe and suitable for clinical use^{126,127}.

Adverse effects of various materials on teeth and oral mucosa

Dental materials can cause adverse reactions in the oral mucosa and teeth in various ways, although the overall incidence is less than 0.3%^{11,59,128-130}. The primary goal of dental procedures such as fillings, crowns, bridges, indirect restorations, and other treatments is to restore proper oral function. However, these procedures can sometimes cause temporary irritation of the surrounding tissues, resulting in pain or swelling¹³¹⁻¹³⁴. Some materials, like dental amalgam, have raised concerns about potential allergic reactions¹³⁵. Amalgam consists of about 50% mercury along with metals such as silver, tin, and copper. Despite these concerns, dental amalgam has been used for nearly 150 years and is valued for its strength, durability, and affordability^{136,137}. Major health organizations such as the Food and Drug Administration (FDA), the World Health Organization (WHO), and the American Dental Association (ADA) consider amalgam safe and effective for the public^{138,139}. Conversely, fillings made from composite resins can sometimes release tiny compounds that may irritate the gums or soft tissues^{140,141}. Even dental devices that rub against the oral mucosa, like braces or dentures, can cause discomfort¹⁴². To choose materials that are unlikely to cause adverse effects, patients should discuss options with their dentist¹⁴³. Since different dental chemicals can have varying effects, it is important to consider each case carefully^{11, 59, 94, 144, 145} (Table 2).

Dental fillings, bridges, crowns, and indirect dental restorative materials aim to restore the stomatognathic system, but these procedures can temporarily irritate surrounding tissues, leading to inflammation and pain¹³¹⁻¹³⁴. Materials such as amalgam, which contains 50% elemental mercury mixed with metals like silver, tin, and copper, have raised concerns about possible allergic risks¹³⁵. Dental amalgam, also known as silver-colored fillings, is a durable, long-lasting, and cost-effective restorative material used in dentistry for over 150 years^{136,137}. Major health organizations, including the Food and Drug Administration (FDA), the World Health Organization (WHO), and the American Dental Association (ADA), consider amalgam to be safe and

effective for the general population^{138,139}. Conversely, composite resins used for fillings can sometimes emit small amounts of chemicals that might irritate the gums or other soft tissues^{140,141}. Even dental devices like braces or dentures can cause soreness if they rub against the oral mucosa¹⁴². Patients should work with their dentist to select materials unlikely to cause adverse effects¹⁴³. Table 2 outlines the adverse effects of several common dental materials, as different substances used in dentistry can have various impacts^{11,59,94,144,145}.

Table 2: Adverse effects on oral mucosa and teeth^{11,59,94,144,145}.

Material	Effects
Oral rinse, gel dentifrice, dental casting materials (temporary materials)	Immune-mediated response
Amalgam	Pigmented lesions of the oral mucosa, gums, and teeth
Ni-Cr alloy	Gingival Hyperpigmentation
Mercury (in amalgam)	Allergic reaction (particularly for Type I/IgE-mediated) in the gingiva, internal cheek lining, dorsum of the hand, tongue, and interface dermatitis
MTA with CHX	Fibroblasts and macrophages % reduced in S phase (DNA) generation, and raised their cytotoxicity
Bis-GMA	Triggers substantially wide range of embryotoxic/teratogenic impact
TEGDMA	It was revealed that possible risk factor for tumor initiation in human salivary glands (over a large range of concentration)
Ag-Sn alloy	Staining of the buccal mucosa
Dental care items, food preservative and taste enhancer	Contact hypersensitivity in the mouth
CHX	Staining of teeth, taste disorder
Stannous fluoride	Yellowing (or yellow-brown discoloration) tooth
Unpolymerized primer and adhesives of adhesive monomers (components of the resin) for dental therapeutic intervention	Cytotoxic to L929 cells (monomers); interaction with these agents must be mitigated.
Denture base repair materials	Presumably cytotoxic and irritant.

Limitations of this narrative review paper

- i. Many studies focus on the immediate effects of dental materials. Since there is no long-term clinical data on late-onset responses or chronic exposure, the full impact of some materials might be underestimated.
- ii. Literature-Based Nature: This study is a narrative review that mainly relies on previously published work. It may therefore carry the shortcomings and potential biases of the included research, such as small sample sizes or a lack of established methodologies.
- iii. Publication bias: This review did not include articles written in languages other than English, unpublished research, or grey literature.

Future Research Recommendation

Further research is necessary to develop advanced dental materials with better biocompatibility, long-term stability, and minimal side effects. Studies should evaluate the delayed and chronic effects of commonly used dental materials. It is important to understand the underlying mechanisms of inflammation and pulp response related to these materials. The safety and effectiveness of dental materials should be assessed by international regulatory agencies. To improve dental material selection, personalized dentistry approaches should be implemented, considering the patient's immune response and genetic predisposition. Addressing current knowledge gaps requires collaboration among clinicians, toxicologists, and dental materials scientists. Research should also include diverse populations and real-world clinical settings to enhance the applicability of findings, ultimately promoting safe and effective dental care.

CONCLUSION

Dental materials, despite their physical, mechanical, and aesthetic qualities, can cause unintended side

effects even with their widespread use in dentistry. These substances have complex impacts on oral health, and individuals react to them in various ways. Although biomaterials are now safer, risks such as allergic reactions and inflammatory conditions still exist. Carefully selecting dental restorations, evaluating them on a case-by-case basis, and performing routine checkups can help minimize these risks. Future research should aim to develop materials with excellent biocompatibility and long-term stability to improve patient safety and treatment outcomes.

Consent for Publication

The author has reviewed and approved the final version and agrees to be accountable for all aspects of the work, including any accuracy or integrity issues.

Disclosure

Mainul Haque works on the editorial board of the Bangladesh Journal of Medical Science. The authors declare that they do not have any financial involvement or affiliations with any organization, association, or entity directly or indirectly related to the subject matter or materials presented in this review paper.

Data Availability

Information for this review paper is taken from freely available sources.

Authorship Contribution

All authors contributed significantly to the work, whether in the conception, design, utilization, collection, analysis, or interpretation of data, or all these areas. They also participated in the paper's drafting, revision, or critical review, gave their final approval for the version that would be published, decided on the journal to which the article would be submitted, and made the responsible decision to be held accountable for all aspects of the work.

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