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Toxicology Versus Allergy in Dental Materials

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ABSTRACT
Dental materials range from polymers to metals that are used to treat tooth decay, replace missing teeth, or even in orthodontic cases. Although all of these materials with a long history of use are tested for their biocompatibility in the oral cavity and their effective role in improving oral health. However, these materials may show side effects that may lead to severe infections or more serious diseases. This review provides an overview of dental materials Allergy and toxicity of different materials in dentistry

Keywords:dental material, allergy, Toxicology, dermatitis, Amalgam.

INTRODUCTION

Teeth are frequently exposed to chemical irritants from dental materials, as various restorative materials and medications used in dental treatment and desensitization cause irritation to varying degrees of sensitivity. Therefore, dental materials should not contain any components that can diffuse into the circulatory system and should not interact with the oral cavity and tissues to cause any systemic response or sensitivity [1,2].
With the diversity of materials used in dentistry, allergic reactions have spread among the majority of patients [3], which requires that these materials used in dental treatment such as root canals and braces meet the specifications of biocompatibility, meaning that the material used is biocompatible, i.e. it is inert and does not interact with the tissues of the mouth and teeth [4].The materials used in dentistry such as latex gloves, materials used in root canal treatment, dental fillings, local anesthesia and other compounds are suspected of causing several health problems such as allergies due to their lack of biocompatibility with the tissues of the mouth and teeth [4,5].
Several literatures have documented potential allergies to dental materials including heavy metals in removable dentures, mercury from silver amalgam fillings and irritant's used in endodontic treatment [6,7].According to Fleischmann (1928), the first case of stomatitis and dermatitis is due to sensitivity to dental metals used in amalgam restorations in the oral cavity [8]. Allergic reactions usually appear in the form of a rash, swelling and runny nose. Moreover, there are life-threatening allergic reactions such as arrhythmia, laryngeal edema and anaphylaxis [6]. The clinical manifestations range from burning, pain and dryness of the mucosa to non-specific stomatitis and cheilitis.Studies also show a decreased inflammatory response to potential allergens and toxicants in the oral mucosa, so that the oral immune system contributes to reducing the degree of reactions to dental materials that may be of allergic or toxic origin [2,9].
Currently, due to the tremendous development in dentistry, treatment techniques and methods, and the use of technology and artificial intelligence in treatment, which has led to the diversity of dental materials. This requires care to meet the needs of the patient and consider the sensitivity of patients to these dental materials in the Kingdom of Saudi Arabia and all over the world.

Contact dermatitis

Contact dermatitis is defined as skin inflammation resulting from exposure to irritants or allergens.Contact dermatitis is divided into two types based on its causes: irritant contact dermatitis and allergic contact dermatitis. Allergic contact dermatitis results from exposure to certain substances that stimulate the immune system to build a reaction to them, and its symptoms appear in the form of changes in the affected person's skin [10].
In dental materials, contact dermatitis can arise from direct contact between the tissues and cells of the mouth with allergens such as resin monomers, monomers, amalgam, bonding agents, the acrylic component in dental

cement, nickel from hard dental wires, latex gloves, etc [7].Symptoms of dental allergy include stomatitis, cheilitis, or contact urticaria with or without spread. Symptoms of this type of contact dermatitis range from redness, itching, skin ulceration, and the appearance of blisters. Most cases of allergic contact dermatitis are not serious, but they cause discomfort until the itching and other symptoms go away [11]. In addition, some types of radiation used in dental diagnosis, and some chemical compounds used in dental treatment, cause genotoxicity, which is known for its ability to mutate DNA. Genotoxicity is the ability of a substance to break down or mutate DNA. Genotoxicity may be caused by certain types of radiation used in diagnosis as well as some chemical compounds used in dentistry [12]. A genotoxic substance is considered a carcinogen because of its ability to change the expression of DNA.

Figure 1: Contact dermatitis amongst dentists and patients

Amalgam tattoo

Amalgam tattoos are a collection of particles or bacteria that settle in the tissues of the mouth, which usually form in the lower jaw of the teeth, and resemble a spot or gray or black color, it may be harmless and sometimes it can spread to another place in the mouth, and some may think of it as mucosal skin cancer [6]. Amalgam tattoos usually appear near the oral cavity but can also appear on the inner cheeks or another part of the mouth, and it appears in the days or weeks following dental treatment such as cleaning or filling, and it is believed that it may take longer, and it does not cause painful symptoms or lead to bleeding [13].The results of a study indicate that one-third of patients with oral lichen planus had allergic reactions to mercury due to amalgams and when the amalgam was replaced with other compounds, the effects disappeared. Burning mouth syndrome was also resolved after amalgam replacement [14].

Figure 2: Amalgam tattoo

Allergy to Latex Gloves

Latex is commonly used in dental materials, such as latex gloves, dental rubber, and orthodontic bands. However, latex can cause various hypersensitivity reactions. This is due to latex proteins that have the ability to penetrate the mucous membrane or skin upon contact, or after inhalation through the respiratory tract, causing various reactions such as allergic reaction, bronchospasm, and stomatitis. Allergic reactions are immediate or may take hours to develop and can extend up to 10 days [15].Healthcare workers and dentists are at higher risk for latex allergy due to sweating and frequent glove changes [2].Furthermore, the use of dental rubber dams causes vascular and delayed hypersensitivity [16].

Figure 3: Allergy to Latex Gloves

Allergy to Resin Materials Composites

Composite resins are a causative agent of allergic contact stomatitis, due to the development of lichenoid-like reactions in the oral mucosa. The pathogenic mechanism may be related to contact sensitivity to formaldehyde formed in composite resin restorations. Formaldehyde causes more than one-third of all allergic reactions to dental materials [2].

Contact dermatitis in dentists is also caused by direct contact with untreated monomers. It causes scaling, itching, and blistering to be limited to the areas of contact [17]. Furthermore, oral manifestations range from burning, pain, and dryness of the mucosa to nonspecific lichenoid reaction, stomatitis, and cheilitis [18].

Allergy to Geographic Lesions

Geographic tongue is an inflammatory disorder, also called erythema migrans, benign migratory glossitis, erythema areata migrans or stomatitis areatamigrans. It is a disorder resulting from the formation of red papillae or scars on the upper surface of the tongue. These scars are distributed randomly on the tongue with scattered cracks that give it the appearance of a geographical map.The conditions are usually asymptomatic, but patients may experience burning in the mouth [19].

Studies suggest that symptoms of a burn in the mouth associated with geographic tongue are due to allergic reactions to metal materials such as amalgam, gold, or orthodontic wires that cause geographic tongue [20,21].

Figure 4: Allergy to Geographic Lesions

Allergy to Local Anaesthetic agents

Anesthesia is a medical procedure in which the patient is given certain medications that cause the patient to lose sensation and feeling. Anesthesia can either be local in a specific area of the body, where the anesthetic medication is given in that area, or it can be general anesthesia that affects the entire body and is performed in major surgeries [22].

Local Anesthetic compounds are divided into two main groups [23]:

- The ester group, which is used in local anesthetic agents, includes tetracaine, benzocaine, and procaine, which have been known to cause allergic reactions.
- The amid group, which includes amino acrylamides such as lidocaine, prilocaine, mepivacaine, and aminoacyl amides such as procainamide and the quinoline derivative dibucaine, which are commonly used by dentists because they cause minor allergic reactions.

Immediate hypersensitivity to local anesthetics is rare, occurring in about 0.5% of cases.In general, local anesthetics produce allergic and toxic reactions, in addition to multiple symptoms such as edema, urticaria, bronchospasm, changes in heart rate, nausea and vomiting.The toxicity of local anesthetics lies in their systemic absorption into the body, which begins with neurological signs such as numbness, dizziness, mood changes, muscle tremors, double vision, and sensory disturbances that may end in coma or respiratory or cardiac arrest [24].

Allergy to Dental Implants

Dental implants have revolutionized dentistry, where the damaged tooth is replaced with another artificial tooth similar in shape and function, and the tooth roots are replaced with metal supports. They contain titanium, vanadium, or metal implants that contain heavy metals such as beryllium (Be), chromium (Cr),andcobalt (Co) [25]. This may lead to acute and chronic toxic effects due to causing cytotoxicity to macrophages and fibroblasts that can bind to iron proteins (ferritin and transferrin), affecting their distribution and accumulation in the body. Also,it leads to local and systemic reactions that prevent cell proliferation with kidney lesions [26].

Figure 5: Allergy to Dental Implants

Acrylics and Other Plastic Chemicals

Due to the toxicity and allergenicity associated with amalgam, acrylics (acrylates and methacrylate's) have replaced amalgam in dental restorations. Methacrylate's have been identified as major contact allergens in the workplace [27]. Contact allergy frequencies to methacrylate's are lower in dental patients than in dental workers, because patients are exposed to uncured acrylic for a shorter period than dental workers and the sensitization capacity of the oral mucosa may be lower, and salivary flow prevents adequate contact [28].

Resin cements

Recently, the chemical properties of resin composites used in dentistry have been improved, however, concerns about their toxicity remain high. This is due to the polymerization reaction in which some components of restorative resin composites are released into the oral environment. As a result of thermal changes, microbial interactions and saliva, the biodegradation of composites is stimulated by saliva [29].

DISCUSSION

In dental materials, contact allergy is a type of hypersensitivity reaction that causes a lesion of the mucous membrane or skin as a result of repeated contact or exposure. There can be a burning sensation on the tongue, and inflammation of the swollen mucosa associated with severe burning [2]. On the hands, it begins with transient blisters, then erupts to form very painful erosions and ulcers. Characteristics of the allergic manifestations are redness, papules, edema and weeping blisters may appear in severe cases [30].According to the FDA, dental amalgam should be avoided in certain populations considered high-risk, such as pregnant and breastfeeding women, children under the age of six, and people with pre-existing neurological conditions [31].A study of allergic reactions to mercury showed that 10 out of 29 patients with oral lichen planus showed an allergic reaction to mercury and when the amalgam was replaced with a composite or glass ionomer filling, the

lesions disappeared [7]. Also, in another study of a patient with BMS, the allergy disappeared after the mercury filling was replaced [32].

The protein content of latex is a known allergen. Allergies to latex proteins, including immediate hypersensitivity reactions and the prevalence of latex allergy, have been well documented [33]. In addition, methylmethacrylate-based acrylic resins can produce hypersensitivity reactions [28]. Studies indicate that the prevalence of contact allergy to methyl methacrylate is 1% [28,34]. Dental implants and the metal materials used in them are a common cause of contact allergy and hypersensitivity reactions, which can lead to adverse reactions in patients [26].The results of a study conducted on 1,500 patients who had dental implants, and monitored them for three years, indicate the emergence of sensitivity to titanium after the implant was placed [35]. Therefore, dentists must take all these considerations and others into consideration when treating patients in order to promote the general health of patients and not just oral health. Paying attention to the patient's history and allergic reactions during dental treatment contributes to improving the diagnosis of the condition and the subsequent action that must be taken in the treatment plan.

A prospective study of patients receiving local anesthesia during dental procedures showed that 25% of the adverse reactions diagnosed were psychiatric or vasovagal [36].

Therefore, dental materials cause allergic reactions and toxicity to both doctors and patients. Patients are exposed to metal hazards, and amalgams have been found to cause most adverse reactions in patients, while doctors are exposed to latex gloves. Metal reactions can occur due to amalgams, base metals, and precious metals. Symptoms are lichen-like reactions inside the mouth or a burning sensation and/or swelling of the oral mucosa. The dental material that causes most adverse reactions in patients is amalgam.

CONCLUSION

Allergic reactions are host immune responses to endogenous or exogenous antigens, which can lead to local and systemic problems. Among the main allergens are dental materials used in dentistry, which face some challenges in terms of biocompatibility with oral tissues and it can be concluded that reactions such as redness, edema, papules, pustules and gingival changes. Therefore, prior knowledge of the dentist is essential for the correct management and treatment of these adverse reactions.

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