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REVIEW ARTICLE

BIOLOGICAL PROPERTIES OF BUILDING DENTAL MATERIALS AND CLINICAL CHANGES IN ORAL TISSUES CAUSED BY THEIR APPLICATION: A NARRATIVE REVIEW

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Restoring the morphological and functional integrity of damaged or lost teeth and replacing them with suitable materials remains a significant challenge in modern dentistry. A continuous development of new restorative materials aims to improve mechanical properties, aesthetic outcomes, and longevity of dental restorations, while minimizing adverse biological effects. Biocompatibility represents a fundamental requirement of all dental materials, referring to their ability to perform a specific function in the oral environment without eliciting undesirable local or systemic tissue responses.

The oral mucosa, including the lips, is constantly exposed to numerous physical, chemical, and biological agents that may act as irritants or sensitizers. Given that most dental materials are designed for prolonged intraoral use, their continuous contact with oral tissues can influence mucosal integrity and function. Clinical manifestations of adverse reactions vary in severity and presentation, often depending on the material composition, exposure duration, and individual patient sensitivity.

Local tissue reactions associated with dental materials include conditions such as oral stomatitis, mechanical trauma, thermal and chemical burns, toxic effects, and allergic reactions. Accurate diagnosis and identification of the underlying causative factor are essential for selecting appropriate therapeutic measures and preventing complications. The growing demand for aesthetic and durable restorations underscores the importance of continuous evaluation and improvement of material biocompatibility in contemporary dental practice.

Keywords: building dental materials, biocompatibility, oral changes, treatment

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INTRODUCTION

Restoring the morphological and functional condition of the destroyed and lost teeth and their replacement is a challenge for the application of new, more effective dental materials and the improvement of those already on the market (1, 2). Today, different types of materials are being used in dental practice, which can be roughly divided into two groups: building materials (acrylate polymers, dental composites, ceramics, and metal alloys) and auxiliary materials (plaster, waxes, thermoplastic, impression, and refractory materials) (3–5).

Modern materials in dentistry should strive to ensure optimal functionality with maximum aesthetic effect. In addition to being effective, they clearly need to be safe as well. Biocompatibility testing has become an indispensable factor in the evaluation of every new material, as well as those already in use (6, 7). Any material that performs a specific role in the organism is called a biomaterial and is expected to fulfill the postulate of biocompatibility. Biocompatibility is the ability of a material to perform a specific function in the body after application without causing a response from the host tissue. They are, in fact, expected to be non-toxic, non-allergenic, non-carcinogenic, that is, to be chemically and physically stable (7–10).

The biocompatibility of materials used in dentistry is determined by their chemical composition (release of substances through solubility and corrosion), as well as the roughness of the material's surface. An unwanted reaction of the oral tissue can be a consequence of the toxicity of the applied material, but also the accumulation of infectious material (3, 11, 12). The response of the organism to the material presence is a dynamic process, given that the tissues and the organism change with aging or under the influence of disease. Material in contact with tissue causes a host reaction, but the tissue also causes changes in the material. Their mutual influence is a dynamic process, which changes depending on the environment. Although unwanted tissue reactions to the presence of dental materials are rare, a large number of daily dental treatments increases the possibility of their occurrence (10–13). The task of biocompatibility testing of materials used in dentistry is to remove each of their ingredients that could potentially cause damage to the tissues of the oral cavity or damage to the organism in general (7, 8).

Dental materials have the potential, thanks to their surface structure, to accumulate saliva ingredients, food and drink residues, microorganisms from the oral environment, forming a biofilm that is a collector of infectious content. Parameters that describe the surface of the material, being also important for biological reactions, are roughness, wettability, chemical composition of the material, electric charge, crystal structure, and heterogeneity (14). Building dental materials are found in the oral cavity in an aqueous environment, and depending on their chemical and physical properties, they dissolve slightly. The release of substances from materials, through their solubility or corrosion, also determines their biocompatibility. These potentially toxic substances can damage cells and cause inflammation or allergy, which can be detected by the secretion of proinflammatory cytokines or interglobulin (15).

The health of the oral cavity depends on the integrity of the oral mucosa, because only an intact oral epithelium prevents the penetration of microorganisms and other harmful agents through the mucosa. Good vascularization nourishes the epithelium, so that in case of damage, the morphological integrity of the epithelium is quickly restored. The physical characteristics of the oral epithelium, thanks to the abundance of elastic fibers, tissue hydration, turgor, and density of the oral epithelium, are such that they can withstand stronger pressure and stretching (13, 14). The sensitivity of the oral epithelium plays a very important role in protection, due to the presence of receptors for touch, pain, cold and warm sensations. The attachment epithelium of the gingival sulcus also opposes the penetration of microbes with its structure, the presence of cells–phagocytes, immune reactions, etc. Keratinization enables proper maturation of cells, including proper mitoses and passage of cells through all layers of the epithelium, when desquamation of old cells occurs on the surface of the mucosa (10–14).

The host tissue responds to the presence of dental biomaterials as foreign bodies with a local and systemic reaction and inflammation. The local effect of the material on the host tissue can be the interaction of the material and body fluids, inflammation, toxic action, allergy, infection, changes in wound healing and possible carcinogenesis (11, 12). Effects of tissues on materials are adsorption of proteins on the implant, enzymatic action, degradation of materials, such as physical-mechanical wear, corrosion, and breakage. Systemic effects would be allergic reactions, systemic toxic reactions, and changes in organ systems (14, 15).

In dentistry, local reactions to the presence of biomaterials primarily occur on the pulp, periodontal tissue, and oral

mucosa. They are related both to the release of potentially toxic substances and to the reaction of tissues to the presence and action of microorganisms on the material surface (16).

DENTAL MATERIALS THAT CAN CAUSE CHANGES IN ORAL TISSUES

Dental acrylates

Acrylates are transparent materials that can be easily colored and shaped to accurately replicate lost teeth, gingiva, and skin. Based on their composition, acrylate materials are polyesters of acrylic acid (17). Their primary use is in the fabrication and repair of denture bases, artificial teeth, removable orthodontic appliances, obturator prostheses and epithesis, various splints, as well as temporary crowns and bridges. Additionally, they serve as auxiliary materials for making custom impression trays, bite rims, and bite templates. Acrylates are also components of adhesive cements and modified glass ionomer cements (18, 19).

Technological advancements have enabled the enhancement of acrylate properties to better meet professional demands. Special attention is given to improving the biological characteristics of acrylates due to reported adverse reactions in both patients and dental staff, caused by potentially toxic substances released during preparation and use (19, 20).

The biological activity of acrylates can be considered in two aspects: their interaction with tissues and environmental agents, and the release of potentially toxic substances that can cause local and systemic side effects. The interaction of acrylate materials with the environment is largely determined by their surface design, particularly roughness. Irregular surfaces are prone to the accumulation of plaque, pigments, food and drink residues, and decayed oral tissue (20–23). Improving the surface structure of acrylates can reduce microbial accumulation. One suggested modification is incorporating phosphate or carboxyl groups into the PMMA structure. Such copolymers acquire a negatively charged surface, which attracts positively charged antimicrobial proteins in saliva, preventing Candida species adsorption and growth. However, these modifications may reduce the mechanical strength of the acrylate (24, 25).

The biocompatibility of different materials is assessed by their cytotoxicity (impact on cell viability) and cytostaticity (impact on cell proliferation) in laboratory conditions. After polymerization, acrylates release certain amounts of potentially toxic substances into saliva, where they dissolve and act upon oral tissues. Their toxic effects are mainly due to unpolymerized acrylate components, unreacted system ingredients, and polymerization by-products (26). Although these substances are highly toxic in concentrated form, their amount dissolved in saliva is generally very small and depends on the material's ability to release them. Residual monomers (such as MMA, BuMA, EMA, and UDMA) or crosslinkers (EGDMA, IBMA, etc.) are considered the main contributors to acrylate toxicity and allergenicity due to incomplete polymerization. Yoshii et al. reported that BuMA and EMA polymers exhibit greater cytotoxicity compared to PMMA. To address allergies to conventional acrylates, new hypoallergenic variants have been developed where MMA is replaced with diurethane dimethacrylate, polyurethane, polyethylene terephthalate, or polybutylene terephthal-ate (20–27).

In most cases, adverse effects of acrylate materials are acute, localized, and resolve quickly upon the removal of the causative agent. Clinically, they manifest as cheilitis, stomatitis, burning sensations of varying intensity, and candidiasis. More severe allergic reactions, such as erythema multiforme, have been reported in response to acrylate dentures. Rarely, chronic prosthetic stomatitis in the form of fibrous hyperplasia occurs in elderly patients. Very rarely, chronic irritation caused by acrylates may lead to oral cancer development (27–30).

Dental composites

Dental composite materials are a realistic realization of the aspiration to compensate for lost dental tissue so that the anatomical and morphological restoration of teeth is not only functional but also aesthetically acceptable. Composite materials are expected to chemically and micromechanically bond to hard dental tissues, creating a unique morphological and functional unit with the remaining dental substance (31). Dental composites structurally compensate for defects caused by tooth decay, fracture, or erosion, and are used to produce fillings, inlays, onlays, overlays, and aesthetic veneers. In addition, composites are used in dental prosthetic therapy for the cementation of highly esthetic ceramic restorations, and in orthodontics for fixing brackets of orthodontic appliances (32, 33).

The profession has set high demands on composite materials:

mechanical (the material must be strong and hard enough, durable, and stable), aesthetic (absolute similarity to the dental substance in terms of color, transparency, and texture) and biological (the material must not act irritatingly or toxic on the pulp and other oral tissues) (34-37). The quality of the composite restoration and its longevity depend on the physical and mechanical properties of the material used. Desirable material properties are hardness, strength, elasticity, as well as resistance to bending, tearing, torsion, and wear. Mechanical properties define the ability of the composite not to change its shape and volume under the influence of load forces (38).

The analysis of biological characteristics of composite materials goes in two directions, to evaluate the release of different components from these materials and their local or systemic interaction with different tissues. Composites can have a negative effect on the surrounding tissues in two ways: by elution of bioactive molecules, primarily residual monomer, and by temperature rise during the binding process (38, 39). The residual monomer release can lead to pulp damage, mucosal irritation, contact dermatitis, and allergic reactions. The allergic reaction of the oral tissue is most often of a local nature, although the possibility of systemic damage is not excluded. The local tissue reaction to the released components of the composite is most often manifested as epithelial proliferation, such as lichenoid change (40). More significant are the changes that the unbound composite can cause on the dental pulp, which gradually range from hyperemia, through inflammation, to tissue necrosis. Systemic effects are also possible, and the ways of spreading are through the oral mucosa, diffusion into the pulp through the dental tubules, absorption of volatile ingredients in the lungs and ingestion of components that are released in saliva. Therefore, it is necessary to prevent unwanted reactions of the unpolymerized composite by optimal polymerization under clearly defined conditions (41–43).

Dental ceramics

Dental ceramics are the material of choice for all types of fixed dental restorations, whether bonded to metal alloy surfaces through oxide formation (porcelain-fused-to-metal, PFM) or used independently as all-ceramic restorations (44, 45). Dental ceramics are usually called inorganic structures that contain a compound of oxygen with one or more metallic or semi-metallic elements such as aluminum, calcium, lithium magnesium, phosphorus, potassium, silicon, sodium, zirconium, and titanium (46, 47).

To be considered as an optimal material, dental ceramics should have the following criteria: not to have a harmful effect on tissues and the body, to be electrochemically stable and not to corrode, to replace the missing tissues with color and appearance, to be easily and simply processed and shaped, that they are stable and create a chemical bond with the metal (48, 49). Dental ceramics are used for making inlays, onlays, veneers, artificial crowns, bridge structures, and factory extensions. Zirconia and glass ceramics are used in periodontology and oral implantology (50).

The biocompatibility of ceramic systems in dentistry can be reduced by the fact that food residues and microorganisms can accumulate on their surface, which consecutively leads to potential infection of the oral tissues with which they come into contact (51, 52). For the material to be considered biologically acceptable, it is necessary that it has such a surface design that it reacts as little as possible with tissue and agents from the environment. The uneven ceramic surface is a predilection place for the accumulation of biofilm, so it can be considered a favoring factor in the occurrence of periodontal diseases, caries, and infections of the oral mucous membrane. Different types of ceramics exhibit varying potentials for biofilm accumulation, with zirconia ceramics demonstrating the lowest propensity for such deposition (53–57).

Dental alloys

Metals in dentistry have multiple purposes. In dental practice, combinations of metals with other elements, dental alloys, are used, with the aim of favoring the desired characteristics of the obtained materials and reducing or eliminating unfavorable ones (58–60).

Dental alloys are in constant contact with oral tissues, so their biological properties are extremely important. The biological stability of alloys must be taken conditionally, and it depends on the chemical composition of the alloy, the crystal structure and homogeneity of the solid solution, the compactness of the surface layers, and the integrity of the protective film (61, 62). The dental alloys biocompatibility is determined by their ability to adhere to biofilm and decay products of the oral environment in a highly corrosive environment such as the oral cavity (63).

The biological reaction of the organism to dental materials is mainly based on the interaction of substances released from the material and relevant biological molecules. The most important biological characteristic of dental alloys is corrosion resistance, which implies the behavior of the material in a liquid medium (64–67). Over time, metal corrosion increases the surface roughness, as well as biofilm adherence, potentiates the release of ions and weakens the restoration construction. The origin of dental alloys corrosion is chemical or electrochemical. The tendency towards electrochemical corrosion arises from the material electrical potential. Two various metals or alloys, immersed in an electrolyte, form a galvanic battery (68, 69). The consequences of electrochemical corrosion are various and can be pain or unpleasant sensations due to galvanic current, a metallic taste in the mouth and, very rarely, changes in the shape of restorations. Dissolved metal can be deposited on soft tissue, creating aesthetically unacceptable oral tissue "tattoos", with a potential harmful effect on their structure (70–72).

LOCAL TISSUE REACTION TO THE PRESENCE OF DENTAL MATERIALS

Biocompatibility of dental building materials refers to the ability of the material to fulfill the desired function, without any unwanted local or systemic effects in the recipient or user of the therapy. However, clinical practice shows that certain toxic ingredients can lead to unwanted changes of a local or, much less often, systemic character (73, 74). Depending on the percentage of toxic substances, these substances could leave the dental restorations and diffuse into the saliva, with which they act on the oral mucous membrane (75).

The mucous membrane of the oral cavity, including the lips, is constantly exposed to many potentially irritating and sensitizing substances. Exposure to certain dental materials can cause reactions in the oral cavity, ranging from mild to severe (76). Most dental materials are designed for long-term use; consequently, prolonged exposure may affect the oral mucosa, leading to a variety of clinical changes and symptoms. Changes to the mucous membrane disappear quickly if their cause is removed (77, 78).

After placing a dental prosthesis, a large number of bacteria in the oral cavity increases further. Namely, between the dental prosthesis and the jaw, a small space is created in which there are perfect conditions for the development of bacteria. Deposits on dentures, such as bacterial plaque, fungi, calculus, and food residues, can be responsible for the occurrence of prosthetic stomatitis, angular cheilitis, inflammatory fibrous, halitosis, dental caries in partial denture wearers, mucositis and peri-implantitis in wearers of mobile superstructures on implants (77–80).

Inflammation of the oral mucosa–oral stomatitis

Stomatitis is an inflammation of the mucous membrane of the mouth, including the inner surface of the mouth, cheeks, gingiva, tongue, and throat. Stomatitis can be acute, chronic, moderate, or severe. Inflammation of the oral mucosa is often secondary because it arises from traumatic damage caused by foreign substances (81). All chemical, mechanical, and thermal factors that compromise the integrity of the oral mucosal surface contribute to the development of this condition (82).

Reactions in soft oral tissues can be caused by materials used to restore damaged and lost teeth. For now, it is unknown whether the materials themselves have a toxic effect or whether the products of bacterial plaque that accumulate on teeth and restorations have such an effect (83).

Inflammation presents with hyperemia and edema. The condition involves the entire oral mucosa, including the gingiva. Marked erythema is observed, the mucosa is swollen, the tongue is coated, and the lips are enlarged. The gingiva is inflamed, with interdental papillae appearing enlarged and prone to bleeding even with minimal contact (82–84).Salivary secretion is increased, and halitosis is commonly reported. Patients frequently experience a sensation of oral decay or a bitter taste in the mouth. Regional lymph nodes are enlarged and tender on palpation. Mild fever, reduced appetite, and exacerbation of pain during eating or speaking may also be present. Common symptoms of an infection of the oral mucous membrane are burning and pain, along with a disturbance in the sense of taste, dryness, difficulty in swallowing, etc. These symptoms are not easy to interpret, as they are subject to subjective interpretation by patients (84, 85).

ORAL TISSUE DAMAGES

Mechanical damages

Damage of the oral mucosa can be caused by physical, chemical, or thermal factors. Damage caused by the physical forces is a consequence of the force action on the oral tissues. The forces that act can be small forces of long duration or cumulative forces, such as those that lead to the formation of a traumatic ulcer. A traumatic ulcer (ulcus decubitalis) can be caused by the action of unrepaired teeth, food, self-biting, orthodontic appliances, and bad mobile prostheses. The cause of the ulcer is visible and recognizable, and the diagnosis can also be established by taking anamnesis (86).

Materials employed in the treatment of oral mucosal surfaces are becoming increasingly common in patients wearing removable dental prostheses. After prosthetic therapy and rehabilitation with mobile restorations, because of increased pressure of the prosthesis on the oral mucosa, damage in the form of erosions and ulcerations may occur. These changes can also occur when wearing inadequate crowns or denture hooks (87). The changes are manifested by pain, which makes it difficult for the patient to adapt to prosthetic replacement. Clinically, a solitary ulcer is visible, covered with a whitish-yellowish fibrin deposit. In deeper changes, mucosal necrosis with infiltrated and raised edges has been seen. The pain appears on provocation (88).

Thermal damages

The oral mucosa is sensitive to the effects of low and high temperatures, and damage is more common under the effects of high temperatures. Heat damages are the most often localized on the tongue and the palate mucous membrane. Heat damage is most often accidental–it occurs due to the use of hot food and drinks, while in prosthetics it can occur when tissue is printed with heated thermoplastic materials (89). They can also occur due to overheating during direct modeling of restorations in the patient's mouth or when determining interjaw relationships, or excessive heating of instruments. Thermal damage also occurs when the prosthesis is placed directly in the mouth, i.e., during polymerization, when heat is released (90).

Clinically, the condition manifests as a red or whitish painful enanthema, which can undergo desquamation, leading to the formation of erosion. In larger tissue damage, necrosis may occur, and in smaller wounds, it may regress spontaneously within a week. The changes in the tissues depend on the length of the action and the temperature (91).

Damages caused by thermal factors are in the form of burns, which can be of the first, second and third degree. First-degree burns are painful, mild injuries that manifest as smooth surfaces. Second degree burns are more severe damage. Redness and edema are more pronounced, and vesicles or bullae may also appear. After spraying bullae, painful eroded surfaces remain. Third-degree burns are very severe damage, which also affect the deeper oral soft tissues. Necrosis may also occur in places of damage. Healing is slow, and after healing, scars remain (90–92).

Chemical damages

Chemical damage to the oral mucosa is caused by the local application of caustic agents or by rinsing the mouth with some liquids in a larger quantity or higher concentration, as well as by treatment in dental practice. The most common localization is on the mucous membrane of the cheek and gingiva (93, 94).

Restorative dental materials, antiseptic substances and endodontic substances are the most common causative agents that are used daily by dentists during routine treatment. Among all dental materials, those in liquid state most often cause chemical damage, because they are difficult to manipulate. Some mouthwashes (if they contain alcohol) can damage the mucous membrane (chlorhexidine, hydrogen peroxide, etc.) (95). The drugs (cocaine, amphetamine) can cause oral lesions. Chemicals are a rare cause of damage to the oral mucosa compared to other damages. Acidic and alkaline substances and their salts cause severe damage to the membrane of the oral mucosa, acting through various pathological mechanisms. Acids cause coagulation necrosis, forming a scar that limits penetration into deeper layers (95–97). Alkaline substances cause damage by liquefaction necrosis, which leads to erosion that progressively spreads. A higher concentration of substances and their longer action lead to greater tissue damage (98).

The clinical condition depends on the composition and concentration of the chemical agent. In the oral cavity, chemical substances can cause various erosive lesions, which range from simple desquamation to complete destruction of the oral mucosa with marked spread through

the basal membrane into the submucosa (97, 98). The wounds are usually irregular in shape, whitish in color and covered with pseudomembranes. The lesions are painful. The affected mucous membrane is covered with a whitish membrane which is the result of necrosis. Necrotic epithelium easily peels off, leaving a red surface that bleeds easily. The diagnosis is made based on clinical appearance and history (97–99).

Oral tissue damages by electric power

Different materials in the mouth, under cer-tain conditions, can lead to complications by generating power, which has no physical electrical source but can endanger the oral tissue. This type of power is called galvanic power–battery, and it belongs to damages by electric power, but of a milder intensity, which occurs due to the incompatibility of some metals in the alloy itself. It is created in the mouth during prosthetic treatment of patients. The generation and intensity of the power depends on the potential and distance of the metal, as well as on the electrochemical reaction of the saliva. The production of electricity is higher if the metal surface of the prosthetic restorations is less polished (78, 79).

Galvanism occurs in the oral cavity when the patient has two or more alloys that interfere with each other and lead to the appearance of symptoms of primary or secondary burning mouth syndrome, because the generated power leads to the appearance of sensations in the form of burning, numbness, bitterness, and similar reactions. It is accompanied by a feeling of metallic taste and increased secretion. There are usually no objective changes on the oral mucosa. This can be explained by the fact that the generated power is of very mild intensity, so that it is not able to cause inflammation or lesion of the epithelium. Pigmented spots may appear on the places of prosthetic metal restorations. Long-term irritation of the oral epithelium caused by a galvanic power of lower intensity can cause increased keratinization of the epithelium. The mucous membrane in those places becomes hard, dry and changes color, becoming white. In this way, true leukoplakia can also occur (100).

Oral tissue damages by toxic materials

There are countless substances that have a toxic effect and cause damage to oral tissues. The most common toxic substances that cause oral damage are heavy metals (mercury, lead, thallium) and metalloids (arsenic, antimony, bismuth) (101). Toxic damage to oral tissues can be caused by phosphorus, copper, silver, iodine, and others. Toxic substances enter the oral cavity: directly, via hematogenous route and saliva. Toxic oral damage depends on the type and nature of the toxic substance, but also on a whole range of local and general factors. The occurrence and severity of poisoning is also influenced by the general state of health, age, diet, sanitary culture, etc (102, 103).

Building dental materials are found in the oral cavity in an aqueous environment, and depending on their chemical and physical properties, they dissolve slightly, but still. These potentially toxic substances can damage cells and cause inflammation or allergy, which can be detected by the secretion of proinflammatory cytokines or interglobulin (104). The most used alloy is titanium, followed by gold and chrome-cobalt alloy, as well as ceramic materials. Composites that are in direct contact with fibroblasts can also have a cytotoxic effect. As for acrylates, the potential cytotoxic effect can be explained by direct contact between the material and host cells. In this case, the cellular reaction can not only be reflected by the tissue's cytotoxic response, but its strength also depends on the characteristics of the material's surface. Cold polymerization of acrylic denture bases shows a greater toxic effect on the cellular structure when compared to heat and light polymerization of acrylate denture bases (102, 103). The cytotoxic effect can also occur due to non-polymerized components and released ions from some metals (nickel, palladium) that can act on soft tissue cells (epithelial, cystoblasts, and macrophages).

The surface roughness of the material increases the degree of inflammation. If the chemical or electrochemical corrosion is greater, the symptoms of the disorder may be stronger. The pain may occur, as well as unpleasant sensations of gal-vanic power, a metallic taste in the mouth and, very rarely, changes in the shape of the restoration itself. Bad aesthetic tattoos of oral tissues can sometimes occur, due to the deposition of metals in soft tissues. In most cases, primary chronic inflammation can occur during the toxic effect of the material, and depending on the material, it can be minimal, and in some cases even moderate (101–105).

Allergic reactions in the oral cavity to dental materials

Allergy (allos-different, ergon-reaction) is a reaction between an allergen and an antibody. It is rare but not impossible for an allergic reaction on the oral mucosa to occur because of the presence of materials from which the prosthetic plate is made, the use of other restorative materials, mouthwashes, for maintaining oral and prosthetic hygiene, etc. (106).

There is often an allergic reaction to prosthetic materials such as acrylates (methacrylates). In such cases, an allergic reaction to acrylates occurs due to the residual methyl methacrylate monomer. The patients feel itching, burning, and if the epithelium is damaged, there is also pain, which intensifies when eating and speaking. If the swelling affects the pharynx, especially the larynx, swallowing and breathing problems may occur (106, 107). Patients experience unpleasant breath because oral hygiene is difficult or absent. Allergy to prosthetic materials develops after inserting or fixing dental restorations made of metal, acrylic and other materials. Hypersensitivity to certain prosthetic materials is characterized by the development of a certain type of allergic reaction.

Allergic stomatitis is characterized by polymorphic clinical manifestations, the nature and extent of which are determined by the degree of sensitization. Changes can affect only certain parts of the oral cavity or all its parts. Changes in the oral mucosa are manifested in the form of allergic contact stomatitis, swelling, enanthema, erosions, blisters, or ulcerations. It is often observed in the presence of metal structure of prostheses, cement, application of toothpastes and mouth rinses, paints, and other materials used in dentistry (108). These materials are steel, cobalt, silver, gold, nickel, manganese, chrome, zinc, amalgam, and others. If we talk about products made of precious metals (gold, silver, platinum), they rarely cause an allergic reaction (107).

Allergic cheilitis can occur because of contact allergy with materials used for prosthetic restoration. The mucous membrane can become sensitive, with the appearance of inflammation, most often to dental materials and devices, such as metal and acrylate fillings, crowns, and prostheses. Cheilitis is characterized by enanthema and edema of the lips, more frequently involving the upper lip. The condition typically develops acutely and is associated with prominent subjective symptoms, including a sensation of lip tightness, pruritus, and impaired mobility of the affected region. Vesicles and bullae may appear, the spraying of which creates eroded lesions, often accompanied by severe pain. After such changes, crusts can also form (78, 79, 109).

Oral lichenoid reactions are conditions with a clearly identified etiology. The most common causative factors are hypersensitivity to dental restorative materials, amalgam, composites, dental acrylates, metals, and accumulated dental plaque. They are caused by the appearance of a contact hypersensitivity lesion and can be diagnosed with a patch test, which shows positive results. Clinical manifestations and history are of particular importance for diagnosis. The reaction to dental materials is a type IV delayed hypersensitivity reaction (110). The lichenoid reaction consists of slightly raised white lines that create islands on the oral mucous membrane. Clinically, they appear as white or enanthematous lesions, usually associated with delicate peripheral white striae. Sometimes there are ulcers in their middle. Erosions like lichen planus erosions often occur. The lesions are localized at the point of contact with the materials applied in the oral cavity. It is characteristic that the lesions occur strictly on the cheek mucous membrane, which is in direct contact with the restorative material, while there are none on the opposite side. They appear as unilateral lesions. The diagnosis is usually made only based on clinical examination (79, 111).

THERAPY OF ORAL TISSUE CHANGES CAUSED BY DENTAL MATERIALS

Stomatitis

A well-established diagnosis is a prerequisite for good therapy and the absence of complications. Treatment of stomatitis depends on the cause. The oral mucous membrane inflammation is treated with antibiotics, local antifungals, removal of all local irritations and rehabilitation of the oral cavity, with frequent local application of antiseptic drugs (76).

Mechanical damage

In these cases, with the application of antiseptics, it is crucial to adapt the prosthesis, if possible. Otherwise, it is recommended to create a new one. Treatment can be carried out by removing the causative factors. A decubitus ulcer heals in 7 to 14 days. If the change does not regress

during this period, an ulcer caused by cancer, tuberculosis or syphilis should be ruled out (77, 112).

Thermal damage

For minor damage, no therapy is required, or laser therapy can be used. In severe cases, preventive antibiotics are recommended, as well as local antiseptics (78).

Chemical damage

The best treatment for chemical damage to the oral cavity is prevention. Superficial damage heals very quickly, in a week or two. In the case of larger damage, good results are given by the local application of corticosteroids. Surgical therapeutic procedures and antibiotics are used in rare cases. Inflammation of the mucous membrane is treated with antibiotics, removing all local irritations, and rehabilitating the oral cavity, with frequent local application of antiseptic drugs (97, 98, 113).

Electrical damage

These damages can be avoided if the same material is used during prosthetic treatment, and the generation of galvanic power is excluded. During repeated prosthetic care, in which material of the same potential is used, all changes are completely lost, and the mucous membrane takes on a normal appearance. In this case, it is very important to choose materials for prosthetics, as well as for implantology, including timely removal of defects and replacement of old prostheses (80).

Toxic damage

Inflammation of the oral mucous membrane is treated with antibiotics, removing all local irritations, and rehabilitating the oral cavity. In the case of larger damage, good results are given by the local application of corticosteroids (104, 105).

Allergy therapy

The therapy of allergies manifested on oral tissues is complex and complicated. The basic approach to treatment is exclusion of allergens. Other therapy is symptomatic, such as coating the lips with antihistamines, less often with corticosteroids, with the aim of alleviating the patient's subjective complaints. In severe cases, but rarely, corticosteroids are used parenterally. The solution to metal allergy is the production of metal-free restorations. Metal-free ceramic crowns have a base of zirconium oxide instead of metal. They are characterized by the absence of allergic reactions and exceptional aesthetics (106–109).

Lichenoid reactions

Therapy is based on replacement of restorative material, as well as polishing and smoothing of fixed materials, as well as good oral hygiene. Sometimes the success of the therapy can be achieved with the local application of steroids. Replacing materials that cause a reaction with hypoallergenic materials leads to a state of complete healing and the possibility of further monitoring of clinical symptoms, which can be more easily controlled (110, 111, 114).

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Competing Interest

The authors declare no relevant conflicts of interest.

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