ZIRCONIUM ALLERGIES CAUSED BY ORAL DENTAL MATERIALS. A GENERAL REVIEW

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Abstract

Dental materials may provoke general or local pathologies and various immune-allergic manifestations. For example, metal allergies are triggered by environmental or – mainly – occupational factors, being more numerous in recent years, particularly through the introduction, in dentistry, of new types of dentures and implants. Zirconium is a transition metal with several beneficial effects, namely: biocompatibility, good aesthetics, slightly translucent fitting, efficient cohesion with ceramics. Pathological effects of zirconium: systemic toxicity (carcinogenic potential), raising syndrome oral allergic dermatitis. Allergists recommend a thorough knowledge on the medical history of patients, on the data of personal and hereditary allergic investigations confirming a possible sensitivity. General and specific allergic investigations for establishing a possible sensitivity to zirconium are: epicutaneous tests, serological tests (TTL) and, and confirmation of allergenic eviction. Equally, balancing of the benefit/cost ratio should be calculated.

Keywords: *zirconium, oral allergic syndrome, dental medicine.*

Dental materials may provoke general or local pathologies and various immune-allergic manifestations. Allergies to metals are triggered by environmental and occupational factors, particularly through the introduction, in dentistry, of new types of dentures and implants. Metals release metal ions which act as haptenes and proteins, forming complexes which can activate the immune system. The reactions to dental materials can be: immune-allergic [1], allergic, of type IV (delayed type LT-dependent) and of type I (immediate) - rare [2] - Figs. 1 to 3).

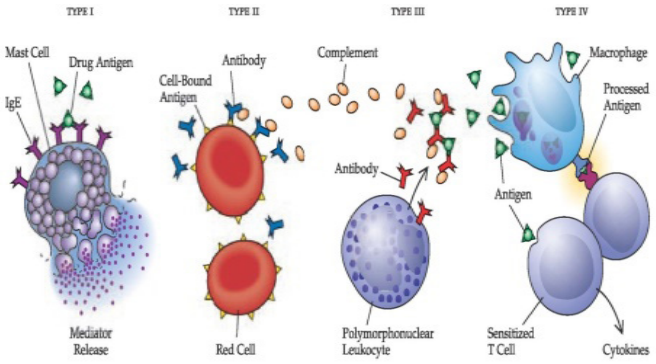

Fig. 1. Immunological reactions according to the classification of Gell and Coombs [3]

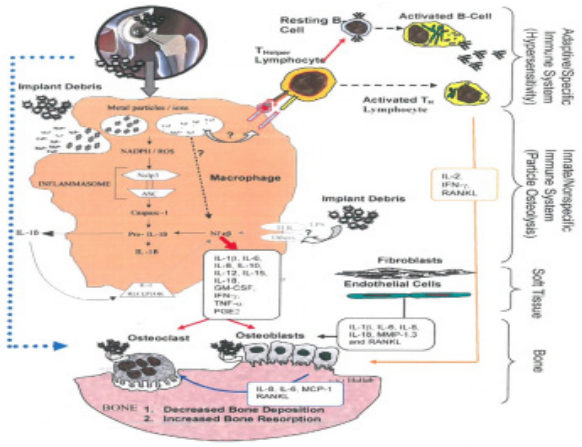

Fig.2. Immune-inflammatory mechanisms of allergic sensitivity in dentistry (Debris-induced inflammation is primarily mediated by macrophages, which ingest the debris, the result being the release of proinflammatory cytokines that affect local cell types and induce an extended soft-tissue damage and inflammation. Courtesy of Bioengineering Solutions, Inc., Oak Park, Illinois)

The toxic reactions produced by metals depend on their quantity, once known that toxins can block the receptors [4,5]. Magnetic resonance reactions may be produced by metals as well as by biophotonic emissions, thus influencing the cellular biochemical processes, provoking modifications which, in their turn, induce various pathologies; they are detected by bioenergetic methods. **Clinical diagnosis** for detecting the sensitivity to metals used in dental implants should be established carefully, after thorough investigations, possibly involving clinical autoanamnesis, as well. The clinical manifestations may be either local, of contact or general. Confirmation of the diagnosis of allergic sensitivity to materials used in dental implants is given by skin and serologic tests [6-9].

Epicutaneous tests (patch) confirm the sensitivity to dental materials, metals, epoxy compounds, gutta-percha [10]. The aspects to be solved refer to: a) is there any risk of hypersensitivity? b) may it cause an inflammatory reaction? c) or a toxic reaction?

The **lymphocyte transformation test (TTL),** discovered around 1960, is a serological test to the cellular immune response against foreign substances [11]. The immunitary system describes LT with memory according to the first contact with unknown foreign antigens, acting upon the antigen-presenting cells [12-14]. **TTL - MELISA** (Memory Lymphocyte Stimulation Assay) is a modern immuno-toxicological technique that allows detection of sensitivity to metals, infectious agents, as well as to metabolites of food and alimentary origin. Metals usually stimulate the immune system, leading to: allergy, autoimmunity, lipidic or supraproteic synthesis through oxidative stress, carcinogenicity caused by nucleic acids [15,16]. TTL measures the proliferation of memory-possessing cells, integrates nucleic acids containing radioactive markers in growing DNA, operates LTH - CD4 and proliferates LT. It may be used as a diagnosis of contact allergies and as an agent preventing the utilization of dental materials [17-19].

Zirconium (Zr), a chemical element with the atomic number 40, is a transition metal.

Determination of tumor necrosis factor, alpha (TNF**α**), is an important cytokine in IgE-mediated allergic reactions, appearing as another diagnosis test [20]. **Genetic tests** can establish the susceptibility to inflammation: interlukine 1 and the receiver of interlukine 1. **Epigenetic tests** can assure a preventive diagnosis and the possibility of using epigenetic markers. The concept of epigenetics, established by Conrad Waddigton in 1942, permitted discussions on the following aspects: molecular processes allow modulation of gene expression, utilization of epigenetic markers, DNA methylation, spatial organization of DNA, non-coding micro-RNA action [21-23].

Fig. 3. Conrad Waddington [24]

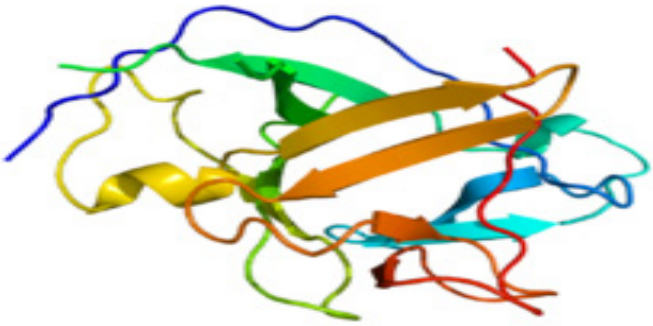

Fig. 4. Interlukine 1 [25]

Zirconium (Zr), a chemical element with atomic number 40, is a transition metal, with a silvery-satin color, belonging, together with titanium and hafnium, to column IVb of the periodic classification of elements. Zirconium is highly resistant to the corrosion induced by water and sea water.

Fig. 5 Zirconium [26]

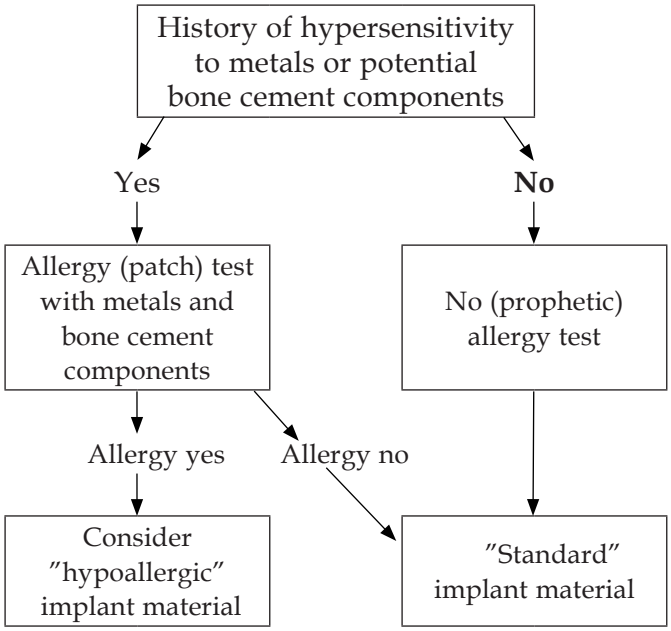

Fig. 6. Flowchart for the evaluation of potential allergy [4]

Fig. 7. M. H. Klaproth [27]

Zirconium was discovered in 1789 by Martin Heinrich Klaproth, in Berlin, as an zirconium extract: oxide of zirconium. Its name: "Zirkon", was attributed by the mineralogist and geologist Abraham Gottlob Werner.

Fig. 8. A. G.Werner [28]

Its Persian name is "Zargun", and "Zarqun" in Arabic, which means "purple". Zirconium: $ZrSiO_4$ appears as a "Hyacinthe" gem stone.

Fig. 9. Hyacinthe [29]

Forms of utilization: oxide, silicate

Zirconium oxide is used for implants and dentures, crowns, collars, intracoronary reconstructions, faceted aesthetic stagings ceramic sintering, dyes, dental plates.

Fig. 10. Zirconium Framework [26]

Advantages of zirconium: biocompatibility, good aesthetics, slightly translucent fitting, effective cohesion with ceramics. Zirconium dioxide (ZrO_2) is used for the manufacture of ceramic tiles and blades (knives). The first ceramic blade was produced by the Kyocera Japanese group in 1984. Pathological

effects of zirconium are represented by: systemic toxicity (potentially carcinogenic), allergic sensitivity (oral allergic syndrome), dermatitis. Zirconium may cause sensitivity when present in the composition of dental materials and also other effects: there exist, for example, deodorant creams containing zirconium and zirconium dioxide. Sensitivity may be also manifested in the industry of explosives, of fire extinguishing materials, of nuclear – yet ceramic – fuel and also in the industry of jewellery, in jewels containing zirconium (imitating gold and diamonds).

Fig. 11. Cubic Zirconia [30]

Zirconium exists in the atmosphere, the allowed amount being of 5 mg / m^3 – which represents an average exposure, as to its duration, and 10 mg / m^3 - as a short duration exposure – according to SIMD classification - Quebec.

The international toxicological sheet should be filled in as a preventive measure against any zirconium-induced pathology [13]. Zirconium used for ceramic implants has a modified molecular form, being considered an "original metal". Zirconium oxide has a stable crystal lattice and is most frequently used in dental implants.

Fig. 12. Implants made of zirconium [14]

Zirconium in its pure form has many qualities: plasticity, electrical conductivity, conductivity to heat, metal glow, sensitivity to corrosion. Zirconium in oxide form is electrically neutral, possesses high hardness, it is white in color, relatively chemically inert, biocompatible, permitting double osseointegration [31, 32].

In dentistry, zirconium entered around the year 1990, in the form of zirconium oxide - as a ceramic material, being wholly accepted in the field. In spite of its side effects, causing immuno-allergy, toxicity, bimetallism, it helps the dental practitioner to make resistant, aesthetic, biocompatible prostheses and implants. The aspect still to be solved is the cost / benefit balance, so that cost-benefit and cost-utility analyses are still necessary to differentiate among the dental implant systems to be investigated in future research [33, 34].

In conclusion, Zirconium is an original metal with many qualities when used as zirconium oxide for ceramic materials, but it may also evidence secondary pathologies, such as immune-allergies with with oral and general localization.

For reducing the sensitivity to zirconium, allergists recommend a careful anamnesis, medical history, observance of one's personal and hereditary allergic signs confirming the extent of sensitivity, epicutaneous and serological (TTL) tests, alongwith specific anti-allergic treatments. Also necessary is to establish the benefit / cost balance.

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