Journal of Scientific Research
Banaras Hindu University, Varanasi

Vol. 60, 2016 : 73-78
ISSN : 0447-9483

TITANIUM CORROSION AND ITS ALLERGY IN DENTISTRY-A SYSTEMATIC REVIEW

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Abstract

The use of titanium in dentistry has greatly increased during recent years due to its passivating effect and resistance to corrosion. Its use for making dental implants to replace the teeth and associated structures is now in common practice. Further it is also used in making cast partial dentures. Many studies have been done to check its tarnish and corrosion resistance or allergic response to it in dentistry. This article will discuss all the recent articles published on titanium corrosion resistance and its allergic response. The allergic response to titanium is reported in very few cases. The purpose of this article is to create awareness among the people handling and using titanium in dentistry so that better strategies can be developed to manage the corrosion and allergic response to it.

Keywords : Titanium corrosion, Allergy, Adverse reactions, Hypersensitivity.

Introduction :

The use of titanium biomaterials has revolutionized clinical oral implantology, and titanium is currently the implant material of choice. It is also used for other purposes like arthroplasty, osteosynthesis, pacemaker cases, oral reconstructive procedures, anchorage of bone conductive hearing aids and epistheses, as well as jewelry for body piercing. It is reported to have very good tarnish and corrosion resistance[1,2]. Whether noble or passivated, all metals will suffer a slow removal of ions from the surface, largely because of local and temporal variations in microstructure and environment. This need not be continuous and the rate may either increase or decrease with time, but metal ions will be released into that environment upon prolonged implantation. Implant corrosion, with the ensuing release of ions/particles to the milieu, is one of the possible causes of implant failure.[3,4]

Degradation products of metallic biomaterials including titanium may result in metal hypersensitivity reaction. Hypersensitivity to biomaterials is often described in terms of vague pain, skin rashes, fatigue and malaise and in some cases implant loss. Recently, titanium hypersensitivity has been suggested as one of the factors responsible for implant failure. Although titanium hypersensitivity is a growing concern, epidemiological data on incidence of titanium-related allergic reactions are still

lacking. All recent articles have been reviewed in the present article. The purpose of this article is to create awareness among the people handling and using titanium in dentistry so that better strategies can be developed to manage the corrosion and allergic response to it.[5]

Titanium corrosion resistance :

Although titanium is considered to be a very biocompatible material but it should be noted, , that no material, including implants, can be considered universally biocompatible.[6] It has been reported that titanium does not withstand a large number of chemical substances. These substances may be in foods, saliva, toothpastes, and prophylactic agents. This stuff decomposes, change plaque metabolism, and cause corrosion.[7]

Abraham et al.[8] demonstrated the presence of titanium in saliva and gingival fluid of patients carrying titanium dental implants. According to the authors, the highest titanium levels corresponded to patients carrying implants over longer periods of time, thus indicating that titanium accumulates in peri-implant gingival tissue.

There are several case reports in the literature that describe histologic evidence of inflammatory response and the presence of metallic ions/particles in the tissues adjacent to orthopedic prostheses of titanium or titanium-based alloys.[9] In addition, some studies have evaluated tissue response of human oral mucosa adjacent to titanium cover screws and found metal particles in the tissues studied; such particles may have been the result of electrochemical corrosion.[10]

Olmedo et al.[11] found macrophages loaded with metal particles as indicators of the corrosion process in the soft peri-implant tissue of failed human dental implants. Microchemical analysis of the particles contained in the macrophages, determined by x-ray dispersion (EDX) analysis, confirmed the presence of titanium. It is worth noting that the number of loaded macrophages was greater in the proximity of metal surface of implants than at a distance from it.

The corrosion process may limit the metal's resistance to fatigue, compromising its resistance, which may eventually cause the fracture of the implant. It has been reported that saliva leaking between the suprastructure (nickel-chrome-molybdenum alloy) and the implant (made of pure titanium) may trigger a corrosion process (galvanic corrosion) due to differences in electrical potential. This generates the passage of ions such as nickel or chrome from the alloy of a crown or bridge to the peri-implant tissues, with consequent bone reabsorption and may compromise the mobility of the implant and its subsequent fracture.[12]

The release of particles from the metal structure of the implant to the surrounding biological compartment, their biodistribution in the organism and their final destination are issues that lie at the center of studies of biocompatibility and biokinetics. The presence of metal particles in tissues in the vicinity of an implant can be the result of a process of electrochemical corrosion, frictional wear or a synergistic

combination of the two. Mechanical disruption during insertion, abutment connection or removal of failing implants has been described as a possible cause of the production of metal particles.

Titanium allergy :

An allergic reaction, or hypersensitisation, is defined as an excessive immune reaction that occurs when coming into contact with a known antigen. Complex relation has been observed between the failure of a metal implant and allergy to its components. In several animal studies a greater concentration of titanium ions in the regional nodes and in pulmonary tissue in specimens with failed implants has been described.

Type I or IV reactions can occur after placing permanent metal dental implants in allergic patients. There are numerous symptoms that have been seen which may range from skin rashes and implant failure, to non-specific immune suppression. Although we know that titanium allergy is uncommon and that not all patients sensitized to a metal display complications following an endosseous implant.[13]

Further, most of the evidence for titanium sensitivity comes from orthopaedic research but its relevance to dentistry must be inferred with great caution. The oral mucosa has different immunological properties than the skin like it is less permeable, contains fewer Langerhan's APCs and is coated by salivary glycoproteins. It has been proposed that oral mucosa must be exposed to allergen concentrations 5–12 times greater than the skin in order to invoke the same stimulus level. Ti allergy can be detected in dental implant patients, even though its estimated prevalence is low (0.6%). A significantly higher risk of positive allergic reaction was found in patients showing post-op allergy compatible response (ACRG), in which cases allergy tests could be recommended.[14]

There are different kind of diagnostic tests to detect the titanium allergy. Epicutaneous tests (patch tests), skin test (prick test) for diagnosing Type 1 allergy[15], the lymphocyte transformation test (LTT) is applied by an in vitro method in mucosal sensitizing allergen. The optimized version of LTT is known as Memory Lymphocyte Immuno Stimulation Assay (MELISA). Local and systemic effects of hypersensitivity resulting from allergies can be analyzed by this method.[16,17]

There can be various manifestations of titanium allergy such as burning or tingling sensations, generally associated with swelling, oral dryness, or loss of taste,[18] or occasionally more common signs and symptoms (eg, headache, dyspepsia, asthenia, arthralgia, myalgia, etc). Allergy in the oral cavity manifests as erythema of the oral mucosa, labial edema, or purpuric patches on the palate, mouth ulcers, hyperplastic gingivitis, depapillation on the tongue, angular cheilitis, perioral eczematous eruption, or lichenoid reactions.[19] Garhammer et al, Lygre et al, Gawrodger have observed

patients with an oral allergy with complain of various symptoms such as burning or tingling sensations, with or without swelling, oral dryness or loss of taste.[20,21,22]

Discussion :

Titanium is currently being used routinely in the manufacture of dental and orthopedic implants due to its excellent biocompatibility. Biocompatibility is defined as the ability of a material to perform with an appropriate host response in a specific application.[23] In cases of fixed partial dental prostheses, porcelain and zirconium oxide might be used instead of conventional dental metals in the near future. However, removable partial denture (RPD) frameworks will probably continue to be cast with biocompatible metals. Commercially pure (CP) titanium is good choice for it as it has appropriate mechanical properties, it is lightweight (low density) compared with conventional dental alloys, and has outstanding biocompatibility that prevents metal allergic reactions.[24]

No metal or alloy is completely inert in vivo. However, as the oral cavity serves as an ideal environment for corrosion, any metal may corrode to some extent in spite of being highly biocompatible. All metals will undergo a slow removal of ions from the surface, largely because of local and temporal variations in microstructure and environment. As the use of titanium is increasing to a great extent in dentistry it is absolutely necessary to have a detailed knowledge of the material.[25]

This can lead to various problems like adverse reactions and allergy in oral cavity and other parts of body. This review of the literature indicates that titanium can corrode and may also induce hypersensitivity response in susceptible patients. Both corrosion and allergy could play an important role in the failure of titanium oral implants and other type of prosthesis used in dentistry. Furthermore, due to a lack of recognition as a possible aetiological factor in implant failure it seems possible that the incidence of allergic reaction to titanium implants may be under-reported. This review indicates that the need for long-term clinical and radiographic follow-up of all patients who have had an implant and who are diagnosed with metal sensitivity. At present, we know little about titanium hypersensitivity, but it cannot be excluded as a reason for implant failure.

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