SOURCE REFERENCES: Dental Toxicity & Biocomp Testing

A Review on Potential Toxicity of Dental Material and Screening Their Biocompatibility
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ABSTRACT

Objectives: A wide range of compounds are utilized in dentistry such as dental composites, resins, and implants. The successful clinical use of dental materials relies on their physiochemical properties as well as biological and toxicological reliability. Different local and systemic toxicities of dental materials have been reported. Placement of these materials in oral cavity for a long time period might yield unwanted reactions. An extensive variety of materials is used in dentistry including filling materials, restorative materials, intracanal medicines, prosthetic materials, different types of implants, liners, and irrigants. The increasing rate in development of the novel materials with applications in the dental field has led to an increased consciousness of the biological risks and tempting restrictions of these materials. The biocompatibility of a biomaterial used for the replacement or filling of biological tissue such as teeth always had a high concern within the health care disciplines for patients.

Materials and methods: Any material used in humans should be tested before clinical application. There are many tests evaluating biocompatibility of these materials at the point of in vitro, in vivo, and clinical investigations.

Results: The current review discusses the potential toxicity of dental material and screening of their biocompatibility.

Clinical relevance: It is essential to use healthy and safe materials medical approaches. In dentistry, application of different materials in long-term oral usage demands low or nontoxic agents gains importance for both patients and the staff. Furthermore, screening tests should evaluate any potential toxicity before clinical application.

It is well established that many common dental procedures and materials can be toxic to the patient, however, the risks of using materials such as mercury in dental amalgam is still promoted as a safe and effective restorative treatment by the dental industry, even though peer reviewed science definitively shows a very different analysis. Another such commonly used material is fluoride. Although fluoride, (the ionic from of fluorine) is a naturally occurring element, fluoride has been added to the water in various parts of the world because it was thought to prevent dental cavities, however, it comes from industrial waste and this practice has been scrutinized since its inception. (SOURCE)

Fluoride-containing toothpaste manufactures post a warning as to the serious risks, however, it is often ignored by the unsuspecting consumer as to its true dangers, especially for children. According to Aoun et al. (2018) more than 80% of fluoride toxicity is seen in children before the age of 6 years, due to ingestion of fluoride-containing toothpaste or mouthwashes. Symptoms resulting from this exposure causing acute toxicity such as nonspecific gastrointestinal disturbances such as pain, nausea, vomiting, and diarrhea. In severe cases, this may progress to

renal and cardiac dysfunction, coma, and ultimately death. Chronic ingestion of high doses leads to dental fluorosis, a cosmetic disorder where the teeth become mottled. In more severe cases, it leads to skeletal fluorosis, in which bone is radiologically dense, but fragile. Fractures can occur, and there may be calcification of ligaments and tendons, leading to reduced joint mobility.

Studies are showing that countries that do not fluoridate water in the prevention of dental cavities, have less cavities than those that do. Additionally, there are so many materials used in dentistry, that the potential for toxic, synergistic effects is only now starting to be studied. (SOURCE A, SOURCE B)

Material Tissue Interaction – From Toxicity to Tissue Regeneration was published by Schmalz et al. (2016) reviewing many dental materials and discussed the inert material concept noting that it is virtually impossible to achieve, and used the term biotolerable materials that don't elicit any clinically significant adverse effects. This paper investigates legal regulations as well as the dentist's liability in treating the patients. The link of exposure to metals and the risks of allergies as well as Bisphenol A, calling it the mercury of the 21st century. "Unfortunately, the dentist is not able to determine whether a resinous material contains Bis-DMA based on the Material Safety Data Sheet, since manufacturers do not always provide such a detailed declaration of material components (see also the material related to referral for allergy testing, above). However, BPA is used during the production process of Bis-GMA and related substances. Despite available purification processes, BPA residues (impurities) exist. Therefore, BPA is found in saliva and urine after placement of resinous materials (sealants and composite restorations). (SOURCE)

Elshahawy and Watanabe (2014) investigated the biocompatibility of dental alloys used in dental fixed prosthodontics due to the permanence of the materials in the oral cavity, and the inability of them to be removed by the patient. They looked at the alloys that were released into surrounding tissues: mainly nickel, zinc, and copper. They noted that some materials such as nickel-chromium alloy were shown to by cytotoxic *in vitro* and also gold alloy released elements that were cytotoxic *in vitro*. Like many materials, and dental materials specifically, are not inert. This study is particularly important in the aging population and how that can affect the health and wellness of the patient. Most importantly this study shines the light on what is mostly unknown to the consumer and the dental professional and what is assumed is "if the material is on the market, its biocompatibility does not need to be questioned. As mentioned before, two systems are currently responsible for standards that can be used to document products quality: ANSI/ADA and ISO. They do not require specific biologic tests to approve the quality of a new dental material. Rather, they place the responsibility on the manufacturer to present evidence for a compelling case for approval. So, it is up to the manufacturer to defend the substantial equivalence argument. The evidences used for approval of quality of a dental material consist of *in vitro* tests (cell-culture), *in vivo* tests (animal tests), and usage tests (clinical trials of the material). However, it is becoming increasingly impractical to test all new materials through all of these stages. The problems of time, expense, and ethics have limited the usefulness of this traditional biologic testing scheme." (SOURCE A, SOURCE B)