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Dental Toxicology: A Review

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Abstract: ***Toxicology deals with the study of chemicals that causes problems for living things in many ways. These chemicals can create a havoc in the human body by interfering with the biological functioning and biomechanisms. The chemicals that cause these problems can be found in various forms and dentistry is not far from the clutches of these toxic substances. In the field of dentistry there are many potential toxic chemicals used in the treatment aspect on the patients, especially in prosthesis and tooth restorations. These include many dental materials such as mercury etc., which can cause toxic effects to human health including genetic mutations or become carcinogenic. The best way to describe a philosophy that can apply to all facets of dental practice and to health care in general is: Always seek the safest, least toxic way to accomplish the mission of treatment. These act as the primary goal of modern dentistry where there is a need to consider the biological aspect and prioritise it. By making distinctions and few changes among the available materials and procedures, we can reduce the impact on our patients' biological responses and terrain. This paper reviews and highlights the causes and effects of potentially toxic materials used in field of dentistry and how to minimise exposure and the plausible repercussions and generating an awareness among the professionals.***

Keywords: toxicology, dental materials, modern dentistry

1. Introduction

Toxicity is not a new term to anyone. From the time immemorial it has been associated with the ever changing world.[1] Whether it's the As per Hindu Mythology during ―Samudra Manthana, a tug of war between the angels and demons or to the medical practice, world has dealt and evolved with tons of toxic substance surrounding us. [2]

Dentistry has evolved over many years and has seen many changes happening over these years. One of the most striking one is the vast amount of materials that are being used to treat the ailments.[3] Whether it's the restorative

Since the time dental practice has evolved, attempts have been made to improve the quality of dental patients with the use of various new materials and devices.[4]Forensic toxicology deals with the investigation of toxic substances, poisonous products or with the environmental chemicals. This field of science helps to identify poison substance and hazardous chemicals. [5]

There's a saying among toxicologists that the dose makes the poison—a chemical that is perfectly safe at one dose may be lethal at another.[3]

Any dental materials used in the oral cavity should be harmless to all oral tissue: gingiva, mucosa, pulp, and bone.[6] Material should contain no toxic, leachable, or diffusible substance that can be absorbed into the circulatory system, causing systemic toxic responses/toxicity (including teratogenic or carcinogenic effects) e.g.substances released intraorally from dental alloys and other dental materials. [7]

Tests done to check for the toxicity

Until recently, almost all national & international Dental standards and tests focused on only physical & chemical aspects.[8] Today, all dental materials require biological testing. Testing is based on specifications or standards established by national or international standards organization, such as the American National Standards (ANSI) or International Standards Organization (ISO).[4]

Testing of materials All dental materials should be subjected to

1) Primary cytotoxicity screening test- to assess any toxic effect at the cellular level
2) Secondary test- to evaluate tissue response (appropriate cell response) Having passed both 1 and 2
3) Animal tests
4) Clinical trial in humans

Ame's test: It was developed by Prof. Bruce Ames in the 1970 and is one of the most widely used in vitro tests. The main agenda for this test was to 'Identifying Environmental Chemicals Causing Mutations and Cancer'. To conduct these test mutant strains of the bacteria Salmonella tymphimurium were used. These bacteria contain mutations in the enzyme that synthesize histidine. Histidine in-turn is responsible for further synthesis of proteins. If any mutagenic substance is present, the growth of the bacteria is evident suggesting mutagenicity.

Dentin barrier test: this is an in vitro test where it tries to mimic the oral environment closely. Also called the cavity method, this tests factor the diffusion of the cytotoxic materials through the dentinal tubules.

Mucosal barrier tests: Three-dimensional co-cultures of human fibroblasts, which are grown on a nylon mesh, were covered with a layer of epithelium cells and have been used to test cosmetic and health care products

Periapical tissue damage and endodontic usage test: This test simulates a reaction that would be elicited following a conventional endodontic treatment. This animal model uses large animals such as primates or dogs. The evaluation is done by histological sections of the periapical region. Intentional necrosis of the pulp to replicate a clinical scenario is also occasionally performed.

Fluoride

Exposure to fluoride is suspected of impacting nearly every part of the human body, and the potential for harm has been clearly established in scientific research.[9]

Statistics kept by the American Association of Poison Control Centers indicate that of all reported cases of fluoride intoxication, 68% were related to fluoride dentifrice ingestion, 17% to fluoride mouth rinses, and 15% to fluoride supplements.

The toxic effects of fluoride are mainly due to:

(a) Burning the tissues (it forms hydrofluoric acid when it comes in contact with moisture, which has a corrosive action),
(b) Impeding nerve function (through its affinity for calcium, which is needed for nerve function),
(c) Cellular poisoning (through the inhibition of enzyme systems), and
(d) Impeding cardiac function (by causing an electrolyte imbalance leading to hyperkalemia).

Restorative materials toxicity

In vitro and in vivo studies have clearly identified that some components of restorative composite resins, adhesives, and resin-modified glass ionomer cements are toxic. The mechanisms of cytotoxicity are related firstly to the short-term release of free monomers occurring during the monomer–polymer conversion. [10]

Secondly, long-term release of leachable substances is generated by erosion and degradation over time.

In addition, ion release and proliferation of bacteria located at the interface between the restorative material and dental tissues are also implicated in the tissue response.

Biological dentistry

"Biocompatible approach is the road to oral health." The hallmark of biological dentistry is a more biocompatible approach to oral health. In the twenty first century biological dentistry if the way to go.

In the old days, when the only restorative materials were amalgam or gold and the only aesthetic material was denture teeth, our profession was hard put to fulfil its mission and be biologically discriminating at the same time.

Today, we can do better dentistry, in a less toxic, more individualized, more environmentally friendly way than ever.

We have as many choices of attitude before us as we do techniques and materials. When a dentist chooses to put biocompatibility first, that dentist can look forward to practicing effective dentistry while knowing that patients are provided with the safest experience for their overall health.

2. Conclusion

When evaluating the mechanism of the biological effects of the dental materials, a wide variety of factors has to be considered.

These include the release of substances from the material when in actual use, the interaction of these substances with the biological environment and the synergistic or antagonist effects of combination of these constituents.

In the long run, final biological evaluation of dental materials has to be done by a group of experts on the basis of published results and adequate knowledge to have more sustainable dental materials.

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