BIOCOMPATIBILITY OF ENDODONTIC MATERIALS

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Abstract:

Materials used in dentistry come into direct contact with the oral mucosa, the pulp, the periapical tissues & the hard tissues of the teeth. Due to this intimate, long term contact, the materials should exhibit a high degree of biocompatibility. Given the importance of biocompatibility to dental materials, it is surprising how few practitioners understand what biocompatibility really is. In this article, the biocompatibility of endodontic materials has been discussed.

Key Words: Biocompatibility, Irrigating agent, Intracanal medicaments, Sealer, Guttapercha

INTRODUCTION

The complexity & technical nature of biocompatibility issues may appear beyond the scope of practicing dentists. However, these issues have profound ethical, social, technical and legal effects on dental practice. Biocompatibility is defined as ability of the material to elicit an appropriate biologic response in a given application in the body.

Ideally, a dental material used in the oral cavity should not interact negatively with oral or dental tissue. In this respect, it should be:

- Harmless to the pulp & the soft tissues.
- It should contain no toxic diffusible substance that can be absorbed into the circulatory system to cause a systemic toxic response.
- Should be free of potentially sensitizing agents that could lead to an allergic response.
- Should have no carcinogenic potential.

HISTORICAL BACKGROUND

Although the concept of ethical treatment of patients extends back to the time of Hippocrates (460-377 B.C), the idea that new dental materials must be tested for safety & efficacy before clinical use is much more recent. As late as the mid 1800s, dentists tried new materials for the first time by putting them into patient’s mouths. Many exotic formulations were used. For example, Fox developed a “fusible metal” that consisted of bismuth, lead, and tin, which he melted & poured into the cavity preparation at a temperature of approximately 100°C. Even G.V. Black used patients to test many of his new ideas for restorative materials, such as early amalgams. In the past decade, new molecular biological & imaging techniques have been applied to assist our understanding of the biological response to materials. Today, the field of biocompatibility testing has reached a point where some prediction of biological properties & the future will likely provide the ability to design materials that elicit customized biological responses.

BIOCOMPATIBILITY REQUIREMENTS

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Certain substances released from some dental materials, may produce biological responses at the localized sites like the pulp, periodontium, root apex, or nearby soft tissues such as buccal mucosa, tongue etc.

These can enter the body systems through several routes, hence, biocompatibility requirements are:
1. They should not be harmful to the pulp or soft & hard tissues of the oral cavity in particular & the whole body in general.
2. They should not sensitize & produce allergic reactions.
3. They should not undergo biodegradations.
4. They should not contain any toxic diffusible substances which get released & enter into the circulatory system.
5. They should not create immune-toxicity i.e they should not alter the cell structures of the immune systems, by changing the cellular functions.
6. They should not be carcinogenic.
7. They should not show estrogenicity & should not contain xeno estrogens.

**BIOCOMPATIBILITY OF ENDODONTIC MATERIALS**

**1. IRRIGANTS & INTRACANAL MEDICAMENTS:**

**SODIUM HYPOCHLORITE:**
Pashley et al. (1985) demonstrated the cytotoxicity of NaOCl using three independent biological models. They found that a concentration as low as 1:1000 (v/v) NaOCl in saline caused complete haemolysis of red blood cells in vitro. Heggars et al. (1991) examined wound healing relative to irrigation and bactericidal properties of NaOCl in in vitro and in vivo models. They concluded that 0.025% NaOCl was the safest concentration to use because it was bactericidal but not tissue-toxic. Different concentrations of NaOCl (e.g. 0.5, 1, 2.5 or 5.25%) are currently used as root-canal irrigants. Clinical tests showed that sodium hypochlorite at 0.5 or 5% concentration has similar clinical efficiency in supporting mechanical debridement of the root canal. Most complications of the use of sodium hypochlorite appear to be the result of its accidental injection beyond the root apex which can cause violent tissue reactions characterized by pain, swelling, haemorrhage, and in some cases the development of secondary infection and paraesthesia. Hypersensitivity reactions to sodium hypochlorite have also been reported.  

**ETHYLENE DIAMINE TETRAACETIC ACID:**
Both neutral and alkaline EDTA showed moderate-to-severe cytotoxicity in a concentration dependent manner. In addition, EDTA has been shown to inhibit the substrate adherence capacity of macrophages as well as the binding of vasoactive peptide to macrophage membranes in vitro. These results suggest that leakage of EDTA to periapical tissues during root-canal preparation may inhibit macrophage function, and thus alter the inflammatory response in periapical lesions. EDTA has been shown to have weak antibacterial and antifungal properties.

**CHLORHEXIDINE:**
It may be a useful substitute in those patients who are allergic to sodium hypochlorite. It is important to note that various symptoms of immediate hypersensitivity, including anaphylactic reactions, have been reported after topical treatment with chlorhexidine. Results from an in vitro study on the toxicity of chlorhexidine to human gingival cells showed that the toxic potency of chlorhexidine is dependent on the length of exposure and the composition of the exposure medium.

**CALCIUM HYDROXIDE:**
Calcium hydroxide has been reported to have a detrimental effect on periodontal tissues when used as an intra canal medicament during routine endodontic therapy. Blomlof et al. (1988) observed that calcium hydroxide could negatively influence marginal soft tissue healing and suggested the completion of endodontic therapy prior to the removal of cementum as might occur during periodontal therapy. Breault et al. (1995) reported that the use of calcium hydroxide demonstrated an increased but not statistical significant inhibition of attached human gingival fibroblasts and proposed that calcium hydroxide should be avoided as an interim medicament when trying to regenerate or establish new attachment in tissues adjacent to endodontically involved teeth.  

2. ABSORBENT PAPER POINTS
There are many brands on the market, and the points are made either to given ISO sizes or in various non-standardized dimensions. The points are often delivered sterile or sterilized, but no information is available on the method of sterilization. Although absorbent paper points are not intended to remain in contact with vital tissue, cellulose particles may be found in the periapical region of teeth associated with inflammatory lesions. Thus, there are reasons to evaluate the biological effects of absorbent paper points used in dentistry. Prior to any extensive usage test, it is recommended that selected initial tests be performed on the to be evaluated for biological responses.

3. SEALERS
Several methods have been used to evaluate the biocompatibility of endodontic sealers. One of the most practical and widely used methods is the implantation of the material into the subcutaneous connective tissue of rats. The irritating effect of the materials can be evaluated by the histopathological examination of tissue response around the implants. Like most sealers AH26 is very toxic when freshly prepared. The toxicity of AH26 sealer is attributed to the release of a very small amount of formaldehyde as a result of the chemical setting process. Calcium hydroxide and Sealapex impaired the status of the periapical tissue when the materials were extruded through the apex.

4. OBTRURATING MATERIALS
Gutta-percha is considered to have acceptable biocompatibility with a low degree of toxicity. It was found that cytotoxic effects varied among brands. Silver points can undergo corrosion. Corrosion of the point with release of toxic products from the metal was believed to initiate or support inflammatory reactions, and the retrieval of silver points lost in the canal of teeth with post-treatment disease cast doubts on the sealing ability of these fillings.

CONCLUSION:
Biocompatibility is very relevant to dentistry because they rely heavily on materials that remain in intimate contact with living tissues for long periods. Decision about the biologic safety of materials are as much philosophical as scientific. Because no material can be proven 100% safe, the decision to use a material in the mouth must balance the potential risks and benefits.

REFERENCES:


