

Cytotoxicity of orthodontic materials – The search for the perfect orthodontic material

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For several years, experimental studies in Orthodontics have attempted to define the mechanical properties of various components of orthodontic appliances to improve bracket¹ and orthodontic cement² shear bond strength, reduce friction of wires and brackets,³ increase force of elastics⁴ and achieve several other improvements.^{5,6,7} However, adverse reactions of the oral soft tissues have raised the interest of researchers in determining the biological effects of these materials, that is, their biocompatibility (Fig 1).

Biocompatibility may be defined as the capacity of a material to perform its specific functions when applied to living tissues of certain hosts without causing any damage or harm.⁸ Orthodontic brackets, for example, should remain in the patient's oral cavity for a mean of 36 months, in close contact with the mucosa, but should not cause any irritation.

As the control of the use of laboratory animals has grown stricter, *in vitro* tests had to be developed and standardized to detect the possible toxicity of the devices to be used in human beings, particularly those for clinical applications, such as biomaterials, which should not expose the patient's organism to any adverse reactions or injury.

According to the International Standard Organization (ISO 10993), *in vitro* cytotoxicity trials should be the first tests to evaluate the biocompatibility of any material to be included in biomedical devices. Only after confirmation of their non-toxicity should the investigation of the product's biocompatibility go on, with the necessary trials using laboratory animals.¹⁰

Several *in vitro* methods are available to test the toxicity of biomaterials.^{11,12} Most tests place the material directly or indirectly in contact with a mammalian cell culture, after which cell changes are evaluated using different techniques, such as the incorporation of vital dyes or the inhibition of cell colony formation.¹³ The most common parameter to evaluate toxicity is cell viability, which may be demonstrated using vital dyes, such as neutral red.¹² Several substances damage cell membranes and decrease neutral red uptake and bonding. Therefore, live cells can be distinguished from damaged or dead cells by measuring the intensity of the cell culture staining using spectrometry.¹²

In vitro methods have advantages over *in vivo* tests, such as the greater control of experimental variables, easier access to significant data and, in many cases, shorter test times.¹²

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

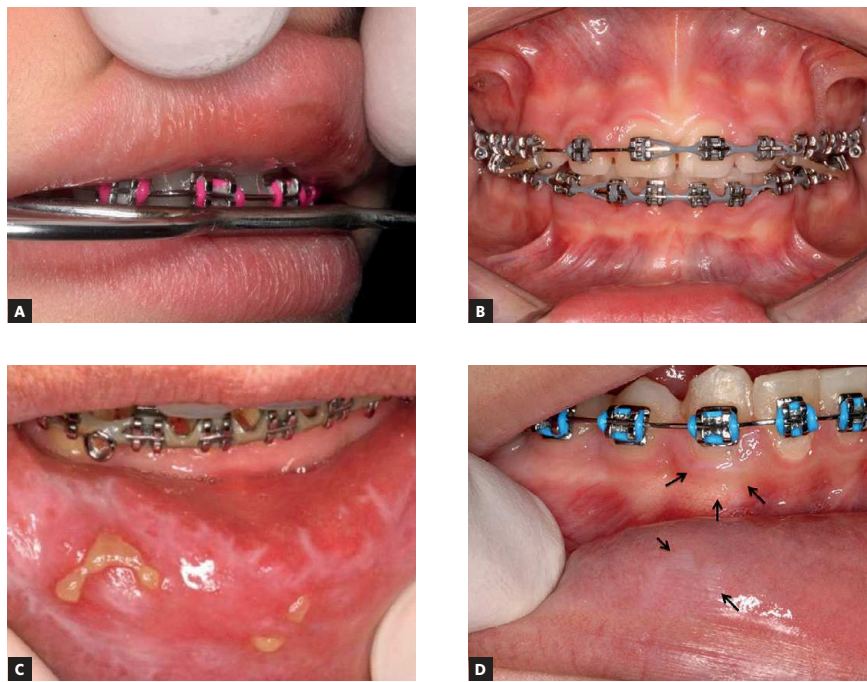


Figure 1 - A) Lip lesion due to contact with orthodontic solder of extraoral appliance. **B)** Inflammatory gingival reaction to contact with bracket bonding resin in patient with good oral hygiene. **C)** Lesion in mucosa after use of intermaxillary elastics. **D)** Lesion in gingiva and lower lip mucosa due to contact of self-conditioning agent in adhesive system.

Biological tests are important because a material to be used in the oral cavity should be atoxic and non-absorbable by the circulatory system and should not injure oral tissues. Non-biocompatible materials may be mutagenic or affect inflammation mediators, which may lead to systemic responses, such as toxic, teratogenic or carcinogenic effects.¹⁴ Such materials should be free of agents that may cause allergic responses in sensitive individuals.

The elucidation of how orthodontic materials behave when in contact with live tissues may bring

answers to several clinical questions, such as: Why is the patient's gingiva hyperplastic even when oral hygiene is excellent? Is the pain assigned to the elastic bands caused only by their movement during use or also by their toxicity when in contact with the gingiva? Important to note that success in clinical orthodontics does not only depend on mastering corrective techniques to achieve ideal dental occlusion, but also demands the application of biosafety norms and the attention to the local and systemic consequences of the use of orthodontic materials.

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