DENTAL MATERIAL BIOCOMPATIBILITY: A CROSS-SECTIONAL STUDY

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Abstract

The aim of this study is to assess the knowledge of the students in the Faculty of Dental Medicine of Iasi on the biocompatibility of the dental materials used in current practice. To this end, we elaborated our own questionnaire, including 10 questions to which 92 students from the last 2 years of study answered. The questionnaire contains assertions on the potential toxic reactions of the most frequently used dental materials. The students answered correctly to the questions related to the biocompatibility of certain dental materials, such as glass-ionomer cement and calcium hydroxide, and they recognized that allergic reactions determined by acrylic resins may occur. We also noticed the lack of knowledge referring to the irreversible modifications produced by the tooth whitening substances on the enamel and dentin, as well as to the side effects produced by dental amalgam.

Keywords: students' knowledge, dental materials, biocompatibility.

1. INTRODUCTION

The field of dental medicine experiences nowadays a real revolution regarding the dental materials, the goal being to synthesize new products superior to the already existing ones, on one hand, and to improve their physical, chemical and biocompatibility properties, on the other. Biocompatibility represents a mandatory requirement of a dental material, expected to reestablish the structure and functions of the tissue with which it comes into contact, without side effects on short or long term [1,2]. The literature quotes numerous in vitro and in vivo studies highlighting allergic, inflammatory, carcinogenic and teratogenic reactions determined by the different types of dental materials, which must not be neglected in current dental practice [3-9]. The dentist should be informed about such manifestations, and capable to choose the type of dental material according to the clinical situation of the patients, their medical history and antecedents. Knowledge of material biocompatibility becomes mandatory, so that, as early as their faculty years, students must be capable to recognize the different lesions present in patients and also to choose the less toxic product for each of them.

Accordingly, the purpose of the present paper is to analyze the knowledge of the students in the Faculty of Dental Medicine of Iasi on the toxicity of different types of materials frequently used in dental practice, from restorative materials and materials used in tooth whitening up to the resins applied in removable prosthodontics.

2. MATERIALS AND METHODS

The cross-sectional study was carried out between January–March 2017, by means of our own questionnaire, made up of 10 questions referring to the biocompatibility of different materials used in dental practice. The questionnaire was filled in by 92 students from the Faculty of Dental Medicine, 51 (55.4%) in the 5th year and 41 (44.5%) in the 6th year. The questionnaire provides affirmations that the students must consider as correct/incorrect, thus testing their knowledge on the side effects of each material.

Statistical analysis was performed using the SPSS 18.0 system for Windows (SPSS Inc. Chicago, IL, SUA). Statistical significance of the bivariate analysis was assessed by Pearson chi-square at 0.05 level.
3. RESULTS AND DISCUSSION

Table 1 lists the answers obtained for the questions provided in the questionnaire.

Table 1. Dental students’ responses to the questionnaire

<table>
<thead>
<tr>
<th>Questions</th>
<th>Correct</th>
<th>Incorrect</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etching enamel surfaces with orthophosphoric acid affects the enamel surface morphology</td>
<td>68</td>
<td>24</td>
<td>0.002</td>
</tr>
<tr>
<td>The 7th generation adhesive systems do not cause the same alterations of the enamel structure</td>
<td>73</td>
<td>19</td>
<td>0.017</td>
</tr>
<tr>
<td>Tooth whitening causes tooth sensitivity, gingival irritation and adverse effects on enamel morphology</td>
<td>60</td>
<td>32</td>
<td>0.032</td>
</tr>
<tr>
<td>Tooth whitening causes alteration of surface microhardness and mineral loss when using 40% hydrogen peroxide</td>
<td>82</td>
<td>10</td>
<td>0.001</td>
</tr>
<tr>
<td>There are risks for the patients when using dental composite resin</td>
<td>81</td>
<td>11</td>
<td>0.016</td>
</tr>
<tr>
<td>The choice of the composite material for crown obturation is made according to patient’s allergic antecedents</td>
<td>49</td>
<td>43</td>
<td>0.215</td>
</tr>
<tr>
<td>Compomers do not determine the same adverse reactions as composite resins do</td>
<td>85</td>
<td>7</td>
<td>0.001</td>
</tr>
<tr>
<td>The following types of dental materials are biocompatible:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- calcium hydroxide</td>
<td>88</td>
<td>4</td>
<td>0.001</td>
</tr>
<tr>
<td>- glass-ionomer cement</td>
<td>85</td>
<td>7</td>
<td>0.001</td>
</tr>
<tr>
<td>The amalgam is toxic due to the release of mercury and it is not used in dental practice</td>
<td>51</td>
<td>41</td>
<td>0.341</td>
</tr>
<tr>
<td>The monomer in the structure of dental prostheses may cause allergic reactions</td>
<td>19</td>
<td>73</td>
<td>0.02</td>
</tr>
</tbody>
</table>

The first aspect considered refers to students’ knowledge on the adhesive systems used during a dental restoration with composite materials. Adhesion at the level of dental enamel assumes the use of orthophosphoric acid (35-37%) which, through demineralization, determines the occurrence of microporosities, which increases the retention of the composite material on the enamel tissue. When the enamel is treated with phosphoric acid of high concentration, an acid-base reaction occurs, with the formation of soluble salts of calcium phosphate, causing an irreversible loss of hard substance. The substance loss, usually between 5 μm and 12 μm, depends mostly on the concentration of acid used and also on the exposure time. Latest researches in the field focused on the obtaining of high performance adhesive systems (the 7th generation) and of simplified application procedures, and also on the increase of biocompatibility through the elimination of acid impairment [10]. The answers recorded showed that 75% of the students correctly considered that the orthophosphoric acid (37%) may alter the enamel structure,
whereas 79.3% of them agreed that the latest generation of dental adhesives exhibit fewer side effects.

Nowadays, tooth whitening is a method used to eliminate dental discolorations through the application of hydrogen peroxide or of its precursor, carbamide peroxide, at concentrations varying between 10% - when using the product at home - and 40% - for safe applications in the dental room. Although the manufacturing companies provide data on the absence of side effects of these products, daily practice has shown that they may cause gingival irritation and tooth sensitivity. Out of the total number of students, only 65.2% recognized the negative effects of teeth whitening, whereas a higher percentage (89.1%) considered that these effects occur only when very high concentrations of active substance are used. Their answers clearly suggest their lack of knowledge in this field, as they took into account especially the practical aspects of the procedure, without considering its benefits and risks, the immediate aesthetic effects and the potentially delayed negative reactions.

The materials used for dental restoration fall into two large categories: composite resin and amalgam. The number of dental restoration made with acrylic materials has increased in recent time, due to their special aesthetic qualities, improved adhesion to enamel and dentin, and also to the controversial aspects on the use of dental amalgam [11]. However, this aspect does not automatically mean that composite resins cannot have toxic side effects, mainly the ones similar to those induced by Bisphenol A-glycidyl methacrylate (bis-GMA) and its derivatives. Numerous in vivo and in vitro studies have shown that side effects are determined by the monomer remained unpolymerized, in amounts varying between 50 and 70%, according to the type of material [12]. It has cytotoxic effects manifested both locally - pulp inflammation, lichenoid reactions of the oral mucosa - and systemically - allergic reactions. In this context, a high number of students (88%) considered that the assertion “There are risks for the who use dental composite resin”, is correct, which cannot be valid for the affirmation “The choice of the composite material for crown obturation is made by taking into account patient’s allergic antecedents”, considered as being true by only 53.2% of the students.

Another aspect clearly indicating the lack of students’ knowledge refers to the use of the compomer type of material. 92.3% of them agree that resin-modified glass ionomer cements like compomers do not determine toxic reactions, as compomers were developed with the aim of combining the positive properties of light-cured composites with those of glass ionomer cements. Unfortunately, this answer is incorrect as, since the residual monomer remained unpolymerized, the hydroxyethyl methacrylate (HEMA) may determine the same reactions – exactly as in the case of conventional acrylic resins [13].

The permanent restoration procedure requires the mandatory use of some additional materials, either to protect the dental pulp, such as calcium hydroxide, or to restore the dentin, such as glass-ionomer cement. From the viewpoint of biocompatibility, glass-ionomer cement is superior to the zinc-oxide cement and polycarboxylate cement, as it shows neither irritating properties at local level nor periodontal reactions. 92.3% of the students considered correct the affirmation regarding the biocompatibility of this type of dental material. 95.6% of them agreed that calcium hydroxide acquires strong therapeutic properties, through its mineralization, protective effects on the dental pulp and also antimicrobial effects, due to its high biocompatibility.

A controversial issue nowadays is on the use of amalgam restoration. The conclusions of the report carried out in 2015 by experts of the European Committee regarding the toxic effects of dental materials clearly show that amalgam filling cannot have serious systemic toxic effects, and that it may be used cautiously only in pregnant women, for reducing fetus’s risk to exposure. Instead, for the general population, the dentists may use the amalgam, on taking into consideration the individual clinical situation of each patient: temporary or permanent dentition, the existence of other amalgam obturations, patient’s allergic antecedent to amalgam and possible kidney disorders [14]. As for the affirmation “Amalgam is toxic due to the release of mercury and it is not used in dental practice”, the percentage of students considering it incorrect was low, of only 45.6%, the rest of them accepting the false idea that the use of synthetic acrylic
materials as an alternative to amalgam represents nowadays a choice for the dental cavity on the posterior teeth. In the dental practice of prosthetic restoration, metals and alloys are used for crowns, and acrylic resins for removable dentures. Just like in the case of crown obturations based on acrylic resins, the excess of methyl methacrylate monomer in the prosthesis may cause stomatitis, irritations at skin level and allergic dermatosis, as well as the burning mouse syndrome [15]. In our study, 79.9% of the students considered this affirmation correct, which suggests that they have sound knowledge on the toxic effects of acrylic resins.

4. CONCLUSIONS

The present study highlights the following aspects regarding students’ knowledge on the biocompatibility of dental materials:

Positive aspects, referring to their knowledge about certain dental materials, such as the biocompatibility of materials for pulp protection, of the 7th generation adhesive systems, were identified. Also noticed was that students are aware of the existence of some potential allergic reactions determined by acrylic resins.

The negative aspects identified refer to the utilization of materials of compomer type, elimination of the amalgam from the current dental practice, as well as the use of peroxide carbamide, regardless of its concentration, for obtaining superior aesthetic aspects.

Having all these in view, we recommend introduction in the training curriculum of some additional courses, which may focus on the biocompatibility of the materials used in current dental practice.

References