Risk factors and preventive measures for occupational diseases in dental technicians

Faktori rizika i mere sprečavanja profesionalnih bolesti kod zubnih tehničara

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Introduction

The construction procedure of fixed and mobile dentures is based on principles of dental doctrine and in the way widely used worldwide. The process of constructing prosthetic restorations and mobile orthodontic appliances is the result of team cooperation between dentists and dental technicians. The work of dental technicians is highly specific and implies construction of mobile and fixed dentures and mobile orthodontic appliances on plaster models obtained by casting individual dental impressions and patients’ jaws. According to the data of the Serbian Institute of Occupational Medicine and Radiological Prevention there are about 3,800 dental technicians, of whom 70% are women 1. The working time in state sector is 40 hours per week, while it is much longer in private sector.

The work in dental laboratory requires ultimate precision and manual dexterity, good vision and ability of recognizing slight differences among variety of hues. All dental restorations are the result of correctly established indication and personal creative expression of dental technician, whereby the final piece placed in a patient’s oral cavity can be considered a tiny work of art.

On the other hand, the work of dental technicians represents a great risk of occurrence of occupational diseases not only due to numerous harmful substances used and released during the process of constructing dentures and orthodontic appliances but also due to inadequate working conditions in dental laboratories and improper protection of the staff. Dental technicians are constantly exposed to harmful effect of different solvents, non-organic acids, evaporations and gases obtained during material exploitation, dust during finishing and grinding, metal alloys, ceramic and acrylates. The group of potentially toxic substances includes methacrylates, silicium dioxide, butylene glycol, hexane solutions, ethyl acetate, nitrocellulose, glutaraldehyde, benzoyl peroxide, hydroquinone, bisphenol A, kaolin and oxides of different metals 2, 3. Concentration values of these substances in the air are very often considerably higher than values of maximum allowable concentrations (MAC), particularly if dental laboratory is without automatic device for measuring air pollution. Particular attention should be focused on methacrylic monomer that is known to have a wide spectrum of detrimental effects such as irritation of skin, eyes and submucose, allergic dermatitis, asthma, and symptoms of central and peripheral nervous system (headache, back pain, nausea, loss of appetite, reduction of gastric motoric activity, tiredness, sleep disturbance, neuropathy, loss of memory) 1, 4, 5. The toxicity of methyl methacrylate was demonstrated in vitro 6–8.

Metal alloys such as vitalium, visil, duralium and viornite are used in construction of crowns, bridges and skeletal partial dentures. Major ingredients of these alloys include cobalt (35–65%), chrome (20–30%) and nickel (0–30%) and small amounts of molybden, silicium dioxide, beryllium, boron and tantalum, the harmful effects of which have already been laboratory and clinically well documented 1, 9. Gold and palladium alloys are rarely used nowadays. Although considered to be relatively bioinert, conjoined allergic reactions to palladium and nickel have been reported 10.

Contact dermatitis

Dermatological occupational diseases occur as a result of irritation or immunological reaction of skin, most often fingers and hands, and rarely face and eyelids (Table 1). Contact dermatitis is mostly occupational disease in industrially developed countries 11, 12. The results of the study conducted by Ruste-
meyer and Frosch show that 16% of dental technicians in Germany have symptoms of contact dermatitis. The prevalence of contact dermatitis is 22% and 43% in Australian and Danish dental staff, respectively. In the last few years an increase of affected persons has been observed. Contact dermatitis of hands is clinically manifested by skin dryness of fingers and hands, redness, broken and peeling skin, itching and pain. The disease improves at weekends and holidays. Mechanical friction (abrasion, attrition), work with plaster, constant changes of temperature and hand washing further contribute to the development of skin changes. When symptoms of dermatitis are present among dental staff the standard Patch test is used for detecting hypersensitivity to a specific group of allergens: methyl methacrylate, potassium dichromate, cobalt nitrate, nickel-sulfate, formaldehyde, hexamethylenetetramine, epoxy resin, phthalic anhydride, mercury precipitate, colophonium, benzoyl peroxide, benzocaine, hydroquinone.

Dental staff is at increased risk of developing contact dermatitis caused by methacrylates molecules which pass through thin latex gloves. Methacrylates represent ingredients of acrylic resins used in construction of plate and skeletal dentures. According to the laboratory investigations carried out by Marks et al. and Werrer et al. immunological reaction to methyl metacrylates was present in 1% of examined subjects. In addition, local contact reactions to butyl methacrylate, urethane dimethacrylate and cross-linking agents (dimethacrylate, ethylene glycol dimethacrylate, 2-hydroxyethyl methacrylate, etc.) were clinically described. Cockayne et al. have described the case of a dental technician allergic to colophonium, the ingredient of numerous waxes used in dentures construction.

Dental staff intentionally avoid using protective latex gloves because of reduced precision in work. On the other hand, various studies report very frequent allergic reactions to some components and plasticizers used for manufacturing these gloves among medical staff. On the basis of literature data it is evident that reactions to wearing latex gloves are present in 5–10% of health care workers in Europe and 17% in the United States and Canada. Systemic allergic reactions to chemical substances that dental technicians come in contact with during their everyday work are, fortunately, very rare. They include type I hypersensitivity reactions manifested as generalized urticaria, bronchial asthma, and very rarely as anaphylactic shock or edema of larynx. Jaakkola et al. in their epidemiological study indicate that medical staff is more often affected by allergic diseases.

**Fig. 1 – Allergic contact dermatitis on the hands of a dental technician caused by methyl methacrylate.**

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**Table 1**

<table>
<thead>
<tr>
<th>Characteristics of reaction</th>
<th>Type I reaction of hypersensitivity</th>
<th>Type IV reaction of hypersensitivity</th>
<th>Irritant contact dermatitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaction of immune system</td>
<td>Systemic IgE-mediated immune reactions</td>
<td>Localized T-cell mediated reaction</td>
<td>Localized inflammation without immune system involvement</td>
</tr>
<tr>
<td>Potential allergens or irritants</td>
<td>Proteins in latex gloves manufacturing, methyl methacrylate</td>
<td>Methacrylates, metal alloys dust, some small proteins</td>
<td>Detergents, acids, alkalis, solvents, continual work in abrasive or wet environments</td>
</tr>
<tr>
<td>Potential risk factors</td>
<td>Allergy to different type of food, allergy to latex balloons, condoms and natural rubber products, continual using of latex gloves, history of allergies (atopy) and eczema</td>
<td>Atopy, skin reactions (eczema and dermatitis)</td>
<td>Atopy, skin reactions (eczema and dermatitis), female sex, age</td>
</tr>
<tr>
<td>Initiation of symptoms</td>
<td>Within minutes or hours of contact</td>
<td>Within hours or days of contact</td>
<td>Within minutes or hours of contact</td>
</tr>
<tr>
<td>Cessation of symptoms</td>
<td>After a few hours of contact</td>
<td>After a few weeks of contact</td>
<td>After irritant removing</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Local symptoms (skin redness and itching, urticaria) often related with systemic symptoms (asthma, bronchospasm, angioedema, coughing, rhinitis, nausea, vomiting, diarrhea, hypotension, tachycardia, anaphylactic shock)</td>
<td>Skin reactions: soreness, redness, cracking, scabbing, crusting, papuling, swelling, itching and pain</td>
<td>Skin reactions: redness, burning, swelling and pain</td>
</tr>
</tbody>
</table>

bronchial asthma if exposed to chemical toxic substances for a long period of time.

Literature data point to link between systemic autoimmune diseases including rheumatoid arthritis, systemic sclerosis and systemic lupus erythematosus and extra work with potentially toxic substances in dental laboratory. Asulillo et al. reported the case of a dental technician affected by Sjögren’s syndrome after long-lasting exposure to silicium dioxide.

### Neurological diseases

During their work dental technicians are in contact with chemical solvents containing hexane and metals (mercury, iron, chrome, cobalt and nickel) that were proven to have detrimental effect on central nervous system. According to findings of Fabrizio et al., 14 out of 27 dental technicians who underwent neurological examination showed some disorders including postural tremor, and Parkinson’s disease was diagnosed in one dental technician. The results of a clinical study conducted by Gorell et al. indicate that long-lasting work with metal alloys increases the risk of developing Parkinson’s disease. Sadoh et al. reported the case of dental technician with generalized neuropathy as the consequence of inhalation with evaporation of methyl methacrylate.

A meticulous finishing of dentures implies extra strain of the eye muscles, which along with increased probability of ophthalmic infections and mechanical injuries represents risk for damaging sight among staff in dental laboratories. Benzoyl peroxide, the initiator of polymerization of methacrylates under in vitro conditions damages fibroblasts of the eye.

### Respiratory diseases

Vaporization of methyl methacrylates and dust which is the result of finishing dentures and metal alloys may lead to damage of nasal cells with subsequent higher susceptibility to respiratory infections. Clinical manifestations of respiratory diseases of dental technicians are cough, enhanced mucous secretion, and decreased respiratory capacity.

Investigations carried out by the Serbian Institute of Occupational Medicine and Radiological Protection indicates that the values of MAC of silicium dioxide in dental laboratories are twofold or threefold higher in relation to prescribed ones. Measured concentrations of methyl methacrylates were 2.4 times higher in relation to allowed values (MAC = 410 mg/m³).

Exposure of respiratory organs to high concentrations of silicium dioxide and dust as a consequence of finishing cobalt-chrome-molybdenum alloy represents great risk of developing pneumoconiosis, the occupational restrictive lung disease. Selden et al. conducted a clinical study in which they found higher incidence of lung fibrosis and pneumoconiosis in Swedish dental technicians who were engaged in finishing cobalt-chrome-molybdenum alloys in relation to a control group. Froudarakis et al. found that the incidence of pneumoconiosis was 9.8% among examined dental technicians in Crete. Pneumoconiosis is particularly common among smokers. Complications of bronchial asthma and rheumatoid syndrome include interstitial inflammation and fibrosis of lung tissue.

### Noise and injuries

Noise in dental laboratory is caused by finishing, grinding, cutting, polishing, as well as ventilation. This type of noise is discontinuous, of wide spectrum with dominant high frequencies. According to the Serbian Institute of Occupational Medicine and Radiological Protection noise in dental laboratory is on the average 92 dB.

Hands of dental technicians are constantly exposed to vibrations of different intensity. “White finger syndrome”, damage of conductivity of nervus medianus is considered to be severe occupational disease of dental technicians.

Regarding the nature of work (ceramics baking, handling spirituous lamp, polymerization of dentures in water bath), there is the risk of skin burn as the result of awkward handling and wearing no protective uniform. While finishing metal and porcelain crowns, dental technicians are exposed to heat and infrared radiation.

### Other risks for health damage

Finishing minor dentures requires high precision and extra strength, so that cramps and painful tension of muscular and skeletal system are possible. Although slight, loading of back and neck should not be neglected taking into account time duration of fixed body position. Work with material taken from patient’s oral cavity is accompanied by risk of developing infection if adequate disinfection is not carried out.

Clinical study on increased risk of developing carcinogenic diseases among dental technicians has not been conducted yet, but there is some evidence suggesting mutagenic effect of particular components of metal alloys such as chrome, cobalt, nickel and beryllium, as well as crystals of silicium dioxide. Choudat suggests link between bronchial cancer, mesotheliomas and dental technicians’ work.

### Preventive measures for dental technicians in workplace

In order to improve life and work efficacy of dental technicians it is necessary to provide them with standardized and optimal working conditions. Dental laboratories, both state and private, should be spacious, clean and well lit. Air pollution is prevented by adequate local and general ventilation system. Dental technician’s workplace should have adequate ventilation system. It should also have separate worktable equipped with kit for grinding, cutting and polishing of dentures, spirituous lamp and hand instruments. In order to avoid damages of musculoskeletal system brought about by strain, adequate adjustable chair should be chosen. Eating,
Drinking and smoking are forbidden at workplace. In addition, it is preferable to have regular shorter breaks spent in a clear air area.

Dental staff should adopt standard procedures for handling with different substances and objects. Manufacture of dentures and orthodontic appliances implies utilization of wide spectrum of different materials that could damage health of the employees. Whenever it is possible, all substances and chemical agents that could be potentially harmful should be replaced with those that are more efficient and less toxic, irritable and sensible. This particularly refers to the use of hypoallergic acrylates and alloys without nickel and beryllium.

It is imperative that dental technicians use adequate personal protection. Protective uniform includes work uniform, protective gloves, glasses and masks. Nitrile and rubber gloves made of synthetic materials are recommended regarding the fact that latex and vinyl gloves do not provide personal protection. Protective uniform includes work uniform.

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While manipulating acrylates a direct contact with non-polymerized mass (no-touch technique) should be avoided. Personal hygiene is important factor in prevention from contact dermatitis. The use of low base soap and lotions is recommended. It is contraindicated to use creams and lotions under latex gloves because they could deteriorate stimulating effect.

In order to reduce harmful effect of vibrations of hand-piece in the process of finishing dentures as well as to avoid continuous exposure of one and the same person to toxic substances and noise, dental technicians should change their tasks, which turned out to be efficient measure. If a person is hypersensitive to a particular substance or working procedure, change of workplace or even change of qualification is indicated within dental laboratory.

Dental technicians should regularly undergo specific medical examinations with primary emphasis on lung function, skin diseases, diseases of ear, throat and nose, disorder of hearing and periphery circulation. Preventive measures also imply health-education work so that the staff could get acquainted with potential risks of their work, early symptoms of diseases, as well as using adequate protection.

**Conclusion**

Dental technicians run the risk of developing local and systemic occupational diseases. Therefore, preventive measures should include adequate workplace, proper equipment handling, selection of biocompatible materials, wearing protective uniform, health-education work and early detection of disease symptoms. The goal of prevention is optimization of working conditions with individual physical and mental capabilities in order to preserve health of dental technicians and thus maintain appropriate level of their working and life skills.

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