# MICROBIAL COLONIZATION OF REMOVABLE ORTHODONTIC APPLIANCES MADE OF DIFFERENT BASE MATERIALS IN CHILDREN AND ADOLESCENTS

**D.A. Domenyuk, L.E. Porfiriadis, E.N. Ivancheva**

*The Department of General Practice Dentistry and Pediatric Dentistry of the Stavropol State Medical Academy, Stavropol*

*D.A. Domenyuk MD*
*355017, Stavropol, Mira str., 310*
*domenyukda@mail.ru*

*E.N. Ivancheva*

## TOPICALITY

One of the acute problems in modern pediatric dentistry and orthodontics is the relationship between tissues and organs of the oral cavity and the construction materials used while manufacturing of laminar prostheses and orthodontic appliances [2].

According to many authors, the most common method of child dentures (tooth replacement) and orthodontic treatment is making of removable appliances and plate denture of acrylic plastic because of their low cost, availability, mechanical strength and technological effectiveness [4]. It was authentically proven that the appliances made of plastics based on hot and cold-cured acrylates, may cause inflammatory and allergic changes in tissues and organs of the mouth because of the impossibility of complete polymerization of the monomer, which is a highly toxic and allergenic. The role of allergens in the acrylates can be played by dyes, opacifiers, plasticizers, catalysts, which are washed out or by saliva or get into the mouth as a result of erasing plastic during functional loads [6]. Negative results that accompany the use of acrylic plastic, show that up-to-date basic materials are needed in the practice of children and adolescents orthodontic treatment [10].

Currently a considerable interest is focused on the microbial contamination of the base materials used for manufacturing of orthodontic appliances [1,5]. The received data concerned colonization and adhesion of microorganisms on the base surfaces of removable appliances in adults [8,9]. However, similar studies of microbial colonization of the basic materials in the pediatric population are rare and not systematic. Virtually there is no comparative data on the bacterial and fungal flora colonizing children orthodontic appliances made of different basic materials.

Comprehensive evaluation of base materials' microbial contamination will provide meaningful data for pediatric dentistry, and individualized evidence-based selection of the plastic base for orthodontic appliances will contribute to the active protection of prosthetic bed tissues [3]. This will improve the overall hygiene status of the oral cavity, provide the long-term stability of treatment results, and retain the structural integrity along with the prolonged life of orthodontic appliances.

***THE AIM:*** Improving efficiency of orthodontic treatment in children and adolescents on the basis of comparative analysis of base materials microbial contamination.

## MATERIALS AND METHODS OF RESEARCHING

Three groups of basic materials used for the manufacture of orthodontic appliances (according to the current international classification ISO 1567:1999 (Dentistry – Materials for denture), were under consideration [11]. In Group 1, basic fast cold-cured plastic based on polymethylmethacrylate (PMMA) Triplex cold (Ivoclar-Vivadent, Liechtenstein) was studied, which is a copolymer based on acrylic resins. The powder was a fine suspension of PMMA containing initiator – benzoyl peroxide, and activator – disulfanil; the liquid was a methyl ester of methacrylic acid containing activator – dimetilparatoluidin. Orthodontic appliances were produced by method of gypsum based hydropolimerization in Ivomat IP3 (Ivoclar-Vivadent). In Group 2, basic hot polymeriza-

tion plastic based on PMMA Prothyl Hot (Zhermack, Italy) was studied, which belongs to the group of graft copolymers based on acrylic resins. The powder was a fine suspension graft copolymer of methyl methacrylate acid; the liquid was a methyl ester of methacrylic acid, containing diphenylolpropane dimethacrylic ester as a cross-linking agent. Orthodontic appliances were produced by method of compression molding in water polymerize Acrydig 4 (F. Manfred). In the third group the base material Triad Denture Base (Dentsply, USA) was studied, which is a cross-linked acrylic resin structured as interpenetrating polymer network not containing PMMA. Orthodontic appliances were made by the technology of gypsum based light cure in Triad 2000 VLC Unit (Dentsply). All the materials were polymerized in accordance with the cycle parameters specified by the manufacturer. After removal of the plaster, each orthodontic device was machined and polished at first with a muslin polishing wheel using pumice and water, and then with polishing paste to the glossy shine. All constructions were placed in distilled water for 50 hours at 37° C.

The study of qualitative and quantitative composition of microflora present on base materials were in 43 children and adolescents with satisfactory and good indices of oral hygiene, who were provided with 49 orthodontic appliances (14 units of materials from Group 1, 17 units of materials from Group 2, and 18 units from the materials from Group 3). The appliances studied in children (teenagers) had been in constant use for 6 months. All respondents were trained in standard methods of cleaning teeth, adapted to their age and the rules of care for orthodontic appliances. Hygiene skills monitoring was held in children aged 7–11 years by means of hygiene index (Fedorov-Volodkina, 1972), 12–16 years old – a simplified hygiene index OHI-S (Green J.C., Vermillion J.K., 1969; Kuzmina E.M., 2001).

In the study of bacterial contamination test materials from the surface of orthodontic appliances were taken from an area of 1 $cm^2$ with a sterile cotton swab and then put into 1 ml of transport medium. Intake area was isolated from the rest of the surface with a special pattern-stopper. Specimens were taken from the apparatus of the upper jaw in the projection of the palatal torus, from the devices of the lower jaw – in the projection mylohyoid torus.

In the study of microbial colonization of the deep layers of orthodontic appliances the shaving was obtained using specially calibrated cylindrical boron with depth 1.0 mm (weight of chips 50.0±1.0 mg). Before the intake of the material the surface was carefully wiped with a sterile cotton swab moistened with isotonic sodium chloride solution followed by washing with sterile distilled water. The test material was delivered to the laboratory within 1 hour, where the dilutions were held in isotonic sodium chloride solution to $10^{-2}$, $10^{-4}$. Inoculation on solid culture media was made from each dilution by conventional methods, in accordance with applicable regulatory microbiological orders. [7] Cultivation of microorganisms was consistently performed in aerobic, anaerobic and microaerophilic conditions in an incubator at 37°C for 24 h and 25–30° C for 48 h to select the fungi.

In a comprehensive study of aerobic and anaerobic microorganisms the inoculations were performed using domestic growth media and media produced by the company BBL® (USA): vitelline-salt agar to select Staphylococci, Endo's medium for Enterobacteriaceae, Sabouraud Dextrose Agar (BBL®) to culture yeast-like fungi, Schaedler Agar (BBL®) with blood and MRS Agar (BBL®) to select anaerobic bacteria, modernized Columbia Agar (BBL®) with blood for the cultivation of H. pylori.

Identification of Enterobacteriaceae was performed using identification systems Enterotube II and Oxi/Ferm Tube (BBL®), and fungi – using Mycotube (BBL®). Identification of the anaerobic bacteria was performed with API systems (Bio Mérieux, (France)) (API 20 A), Streptococci with API 20 Strept, and Staphylococci with API 20 Staph. Schaedler Agar and Columbia Agar were used to study hemolytic activity, and vitelline-salt agar to study lecithinase activity. The ability of bacteria to inactivate lysozyme, produce catalase, ribonuclease, caseinase and urease was also studied.

In a quantitative study of bacteria and evaluation of colonization degrees (based on the number of colonies grown in primary inoculations) the content of each species of bacteria per 1 $cm^2$ of adhesive films for the collection of material (CFU/$cm^2$) were measured. For the convenience of calculation, the values of microbial contamination were converted into decimal logarithms (lg CFU/$cm^2$).

## RESULTS AND DISCUSSION

Identification of the species colonizing the surface of orthodontic appliances from cold-cured base plastics showed 16 genera of microorganisms: Staphylococcus, Streptococcus, Lactobacillus, Bacillus, Peptococcus, Peptostreptococcus, Porfiromonas, Bifidobacterium, Veillonella, Micrococcus, Leptotrichium, Fusobacterium, Prevotella, Actinomyces, yeast-like fungi of the genus Candida and Enterobacteriaceae, five of which can be of etiological importance (Staphylococcus, Bacillus, Peptostreptococcus, Fusobacterium, Prevotella). In the depth of cold-cured plastics four kinds of opportunistic or etiologically important

bacteria with lecithinase, ribonuclease, and proteolytic activity were revealed.

In the study of surface microbial contamination of the orthodontic appliances made of hot polymerization base materials 14 genera of microorganisms were identified: Staphylococcus, Streptococcus, Lactobacillus, Bacillus, Peptococcus, Peptostreptococcus, Porfiromonas, Bifidobacterium, Veillonella, Micrococcus, Leptotrichium, Actinomyces, yeast-like fungi of the genus Candida and Enterobacteriaceae, including three etiologically significant (Staphylococcus, Bacillus, and Peptostreptococcus). In the depth of hot-cured plastic three kinds of opportunistic bacteria with lecithinase, ribonuclease, and proteolytic activity were found.

In the study of surface microbial contamination of the orthodontic appliances made of light-cured base materials 7 genera of microorganisms were identified: Staphylococcus, Lactobacillus, Bacillus, Peptococcus, Peptostreptococcus, yeast-like fungi of the genus Candida and Enterobacteriaceae; there were not any pathogens found. In the depth of a light-cured plastic prosthesis there was only one etiologically significant bacterium with ribonuclease and proteolytic activity

The quantitative data concerning the colonization of base materials Triplex cold, Prothyl Hot, and Triad Denture Base (surface and depth) are represented in Table 1.

Quantitative analysis of the surface/depth bacterial contamination of orthodontic appliances showed that quick cold-cured base plastics are the most susceptible to microbial colonization, exceeding the corresponding figures of the hot polymerization base materials 2,4±0,2 (2,3±0,2 ) times, and exceeding the parameters of microbial contamination of the light polymerization base plastic 3,8±0,3 (3,6±0,3) times.

## FINDINGS

1. The proposed method of in vitro comparative evaluation of the different base plastics' microbial colonization helps to assess the level of bacterial contamination of orthodontic appliances in children and adolescents fairly and precisely.
2. The number and frequency of revelation of various microorganisms, including etiologically significant, depend on the chemical class of the base material from which the orthodontic appliance is made and its type of polymerization (cold-, hot-, or light-cured).
3. Adhesion of stabilizing resident bacterial species can be detected in the study for all the base materials for orthodontic appliances in children and adolescents, although microbial contamination in light-cured plastic base Triad Denture Base was significantly lower than on plastics of hot and cold polymerization types.
4. Microbial colonization of the appliances made of light-cured plastic Triad Denture Base is characterized by absence of the majority of opportunistic microorganisms in the prosthetic biofilms,

***Table 1.*** *Colonization of the surface/depth of base materials Triplex cold, Prothyl Hot, and Triad Denture Base (lg CFU/cm²)*

| | Base material | | | | | |
|---|---|---|---|---|---|---|
| | Triplex cold | | Prothyl Hot | | Triad Denture Base | |
| | Surface | Depth | Surface | Depth | Surface | Depth |
| Staphylococcus | 7 | 6 | 5 | 4 | 2 | 1 |
| Streptococcus | 9 | 9 | 6 | 5 | | |
| Lactobacillus | 18 | 17 | 12 | 11 | 5 | 3 |
| Bacillus | 7 | 7 | 4 | 3 | 2 | 1 |
| Peptococcus | 17 | 15 | 11 | 9 | 5 | 4 |
| Peptostreptococcus | 6 | 5 | 4 | 3 | 2 | 1 |
| Porfiromonas | 6 | 5 | 3 | 3 | | |
| Bifidobacterium | 7 | 7 | 4 | 4 | | |
| Veillonella | 6 | 6 | 4 | 3 | | |
| Micrococcus | 7 | 6 | 4 | 4 | | |
| Leptotrichium | 6 | 5 | 3 | 3 | | |
| Fusobacterium | 5 | 4 | | | | |
| Prevotella | 6 | 5 | | | | |
| Actinomyces | 4 | 3 | 2 | 1 | | |
| Candida | 11 | 10 | 7 | 6 | 3 | 2 |
| Enterobacteriaceae | 12 | 12 | 9 | 8 | 4 | 4 |

creating optimal conditions for the microecological balance maintenance in a mouth cavity, while improving its overall hygiene. This helps to prevent complications and improve the quality of orthodontic treatment in children and adolescents.

## REFERENCES


1. **Borisov, L.B.** Microbiology and immunology of oral diseases / Ed. L.B. Borisov // Medical Microbiology, Virology, Immunology. – M.: Medicine, 1994. – P. 496–522.
2. **Vinogradova, T.F.** Prevention of dental diseases in children / Ed. T.F. Vinogradova // Child Dentistry: A Guide for Physicians. – M.: Medicine, 1987. – P. 34–95.
3. **Domenyuk, D.A.** Rating of metal-acrylic dentures influence on colonization of pathogenic microflora / D.A. Domenyuk, S.N. Garazha, E.N. Ivancheva // Russian Journal of Dentistry. – 2010. – № 5. – P. 8–11.
4. **Kolesov, S.I.** Materials and technology of construction materials / Kolesov S.I., Kolesov I.S. – M.: Vysshaya shkola, 2004. – 268 p.
5. **Kuznetsov, E.A.** Microbial flora of the oral cavity and its role in the development of pathological processes / E.A. Kuznetsov, V.N. Tsarev, M.M. Davydova / / Tutorial for students, interns and dentists. – M.: Znanije, 1995. – 285 p.
6. **Lanina, S.Y.** Methodological and procedural issues of hygiene and toxicology of polymer materials and medical products / Lanina S.Y., Ivlev A.L., Vdovina Z.N. – M.: Medicine, 1984. – P. 60–67.
7. Order of MoH USSR № 535, 22.04.1985. On the unification of microbiological research methods used in clinical diagnostic laboratories of medical institutions.
8. **Rubezhov, A.L.** On the various factors affecting the periodontal tissues in patients who use dentures / A.L. Rubezhov // New in dentistry. Spec. release. – 1996. – № 4. – P. 77–81.
9. **Rubezhov, A.L.** Prevention of periodontal diseases in patients with orthodontic appliances / A.L. Rubezhov, T.J. Soboleva // Digest of scientific and practical materials. Conf. "Prevention and treatment of major dental diseases". – Izhevsk, 1995. – P. 73–74.
10. **Trezubov, V.N.** Prosthetic Dentistry. Applied Materials / V.N. Trezubov, L.M. Mishnev, E.N. Zhulev // Tutorial for medical schools. – Moscow: MED press-inform, 2008. – 373 p.
11. International Organization for Standardization. ISO 1567:1999 Dentistry – Denture base polymers. Geneva: International Organization for Standardizations; 1999.


# *in brief...*

### Schlaganfall: Im Zweifel pro Lyse

Deutlich mehr Schlaganfall-Patienten als bisher sollten eine Lyse-Therapie erhalten. Das ist die Kernaussage der weltweit größten Thrombolyse-Studie IST-3 und einer Meta-Analyse mehrerer kürzlich veröffentlichter wissenschaftlicher Arbeiten.

„Diese Daten untermauern unsere Empfehlung, die Lyse noch mehr in der Routine-Therapie zu verankern", kommentiert Professor Martin Grond, Vorstandsmitglied sowohl der DGN (Deutsche Gesellschaft für Neurologie) als auch der DSG (Deutsche Schlaganfall-Gesellschaft).Bisher sucht man eher nach Gründen, die Lyse nicht durchzuführen – wir sollten aber eher die Lyse als Standard betrachten, statt die indizierten Patienten zu selektieren."

*Originalpublikationen:*

Recombinant tissue plasminogen activator for acute ischaemic stroke: an updated systematic review and meta-analysis

J.M. Wardlaw et al.; The Lancet Vol. 379; *doi:10.1016/S0140-6736(12)60738-7; 2012*

### Depression: Klare Sicht voraus

Forscher haben nun eine Methode entwickelt, mit deren Hilfe in Zukunft der subjektive Zustand von Depressionen objektiv gemessen werden kann.

Grau und Schwarz sind die Farben, die für Melancholie oder Depressivität stehen. Im Englischen dagegen wird die niedergedrückte Stimmung mit der Farbe Blau in Verbindung gebracht, etwa, wenn ein deprimierter Mensch sagt: "I'm feeling blue". Dass sich hinter diesen Sprachbildern auch eine empirische Wirklichkeit versteckt, hat nun eine Arbeitsgruppe am Universitätsklinikum Freiburg mit Wissenschaftlerinnen und Wissenschaftlern aus Psychiatrie, Psychotherapie und Augenheilkunde herausgefunden.

*Originalpublikation:*

Effect of antidepressive therapy on retinal contrast processing in depressive disorder M. Bach et al.; Br J Psychiatry.; 2012