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Basic Materials Used in Removable Orthodontic Constructions in Children

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Annotation: The rapid development of modern orthodontic technology has led to the widespread introduction of previously unused structures of orthodontic devices made of various groups of restorative materials [7, 8, 14].

Keywords: orthodontic technology, restorative materials

The basis of the orthodontic design during the entire period of treatment in the oral cavity not only contacts the enamel of the teeth and the adjacent tissues of the oral mucosa, but also constantly interacts with the main biological medium – oral fluid, causing certain changes in it that have a pronounced adaptive-compensatory character [1, 2, 18, 19, 23]. The problem of increasing the effectiveness of biophysical studies that allow to establish the physical parameters of unstimulated oral fluid (NRF) at the stages of orthodontic treatment is currently of considerable interest [13, 16]. It has been revealed that at the initial stages of orthodontic treatment, when mechanically acting and functionally guiding devices are used, a statistically significant change in the qualitative and quantitative composition of HPV occurs [3, 4, 9]. The study of HRH indicators in the treatment of dental anomalies with the use of removable orthodontic equipment in children, which allows to objectively assess the timing of normalization of biophysical parameters, is presented in isolated works and has no systemic character. In the available scientific literature there is no information about the terms of adaptation of the child population to various groups (classes) of basic materials used in hardware methods of treatment. The systematization of the biophysical indicators of HRH will allow us to reliably assess the effectiveness of adaptive mechanisms after the imposition of removable orthodontic equipment in children and obtain significant results for dentistry. Individualization of indications based on a reasoned choice of basic plastics for orthodontic devices will help to reduce the adaptation period while optimizing the biophysical parameters of the LVH. In addition, the selective use of basic materials in the initial period of orthodontic treatment will contribute to the normalization of microcirculation in periodontal tissues, the preservation of local and humoral immunity, and the establishment of an equilibrium state in the "enamel" environment./saliva", as well as maintaining the homeostasis of NRH in order to prevent the development of the carious process, inflammation of the tissues of the prosthetic bed with long-term stability of therapeutic and preventive measures. The aim of the study was to evaluate the influence of basic materials used in removable orthodontic equipment in children on the adaptive mechanisms of oral fluid according to biophysical indicators. Materials and research methods From the modern international classification ISO 1567:1999 (Dentistry – Materials for prosthetic bases), we have identified three types of basic materials used for the manufacture of removable orthodontic devices [20]. The type 1 material is

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represented by the base plastic of the cold curing method based on polymethylmethacrylate (PMMA) "Meliodent RR" ("Heraus Kulzer", Germany), which refers to a copolymer based on acrylic resins. Powder – fine, suspension PMMA containing the initiator – benzoyl peroxide and activator – disulfanyl; liquid – methacrylic acid methyl ester containing activator – dimethylparatoluidine. Orthodontic constructions were made by the method of gypsum-based hydropolymerization in the device "Ivomat IP3" ("IvoclarVivadent"). The type 2 material is represented by a basic plastic of hot polymerization based on PMMA "Prothyl Hot" ("Zhermack", Italy), belonging to grafted copolymers based on acrylic resins. Powder is a finely dispersed, suspended and grafted copolymer of methyl ether of methacrylic acid; liquid is methyl ether of methacrylic acid containing a cross–agent – dimethacrylic ether of diphenylopropane. Orthodontic constructions were made by compression pressing in a water polymerizer "Acrydig 4" ("F. Manfred"). The type 3 material is represented by the basic material "Versyo" ("Heraus Kulzer", Germany), which refers to a cross-linked composite acrylic plastic with an interpenetrating polymer mesh structure. The monomer system is represented by a mixture of multifunctional radicals with high molecular weight without PMMA. The content of inorganic filler (SiO2) is 8%, the particle size is 0.6–0.8 microns. Orthodontic structures were manufactured using gypsum-based light-curing technology with preliminary polymerization in the Heralight apparatus (Heraus Kulzer) and final polymerization in the Heraflash apparatus (Heraus Kulzer). All materials were polymerized at the cycle parameters specified by the manufacturer. After the gypsum was removed, each mechanically functioning orthodontic apparatus consisting of a base material and metal elements was processed and polished first with a muslin polishing wheel using pumice stone with water, after which with a polishing paste to a glossy shine. All designs were placed in distilled water for 50 hours at 37 ° C. The study of the biophysical parameters of NRH was carried out in 73 children aged 4.5 to 8 years with satisfactory and good indicators of oral hygiene. The patients were divided into a control group and three main groups of dispensary observation. The control group consisted of 18 children with orthognathic bite without defects of dentition, who are undergoing preventive examination and do not need orthodontic treatment. The 1st group included 19 patients with anomalies of the position of the teeth without defects of the dentition, who had 23 orthodontic devices made of type 1 material. The 2nd group included 18 patients with anomalies in the position of teeth without dentition defects, who had 24 orthodontic constructions made of type 2 material. The 3rd group included 18 patients with anomalies in the position of teeth without dentition defects, who had 23 orthodontic devices made of type 3 material. The studied devices were in constant use in children for two months. It was recommended to use such devices daily, starting from 1-1.5 hours and gradually up to 4-5 hours a day by the 14th day and then up to 18 hours a day by the 60th day. All the subjects were trained in standard methods of brushing their teeth, adapted to their age, and the rules of care for orthodontic structures. The control of hygienic skills in children was carried out according to the hygiene index (Fedorov – Volodkina, 1972) . To assess the adaptive mechanisms of patients of all groups using clinical and laboratory methods, the following biophysical studies of HPV were carried out: determination of the test of ductility, microcrystallization test, adsorption capacity of epithelial cells of COPR. HPV collection was carried out in the clinic on an empty stomach from 8 to 9 a.m., four times (before

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the start of treatment; after 14 days; after 30 days; 60 days after the start of orthodontic treatment). Patients were asked not to perform procedures that stimulate salivation: refusing to eat, using chewing gum, it was recommended not to brush teeth, not to rinse the mouth. Professional teeth cleaning was carried out before the start of orthodontic treatment. To collect unstimulated mixed saliva, the patient was seated, asked to lower his head and sit in this position without swallowing saliva. The saliva accumulated in the oral cavity was spat out by the patient into a sterile graduated cooled silicone tube of Swedish manufacture, the inner surface of which was treated with enzyme stabilizers. The analyses were carried out within 20-30 minutes after sampling using biophysical methods of oral fluid examination recommended by the Central Research Institute of Dentistry (1991). Methodology for determining the test of ductility (graduation level) (P. A. Leus, L. V. Belyasova, 1995) consists in the fact that from the saliva accumulated for 2 minutes in the sublingual area, with the help of dental tweezers, thin threads are pulled out. Thread breaking occurs at one level or another, which is the basis for the allocation of four gradations of the viscosity test: sharply positive test (thread breakage at the level of the scalp and above), positive (thread breakage at the level of the brow arches), negative (thread breakage at the level of the wings or the tip of the nose), sharply negative (thread breakage at the level of the central teeth of the upper jaw or upper lip) [10, 11]. Microcrystallization was investigated according to the method proposed by P. A. Leus (1977) [11, 12]. 3 drops of saliva were applied to the slide using a pipette and dried at t 37 ° C. The preparations were examined under the Levenhuk 320 light microscope (Russia) in transmitted light by the light field method at low magnification. Dried drops of oral fluid were examined using a binocular stereopancratic microscope "MSPE-1" (Russia) in reflected light with lateral and vertical shadowless illumination at low magnification. Photographing of crystals was carried out through a microphotometer of the company "CARL ZEISS JENA" at the same magnification. The determination of the microbial adsorption reaction (RAM), indicating the nonspecific resistance of SOPR, was carried out by counting the number of bacteria adsorbed on the surface of each epithelial cell (calculated per 100 cells), according to the method of T. A. Belenchuk (1987) modified by S. I. Tokmakova et al. (2002). Using this technique, under the Levenhuk 320 light microscope (Russia), smears of epithelial cells were examined in transmitted light by the light field method at low magnification and the number of microorganisms adsorbed on the surface of epithelial cells was calculated [5, 15]. Statistical processing was carried out on a computer using the program "Microsoft Excel" and the package of application programs "Statistica 6.0". The data are presented as mean and standard deviations for a normal distribution and as median and interquartile range for a distribution other than normal. The significance of the differences for quantitative variables between the groups was assessed by the Wilcoxon and Mann-Whitney criterion. The results of the study and their discussion A comparative analysis of the examination of patients in the control group found that the fluctuations in the indicators of HPV ductility vary from 3.0 ± 0.1 to 3.2 ± 0.2 units. The average value of HPV ductility (3.1 ± 0.1 units) was taken as a conditional norm, which objectively reflects the fluidity of unstimulated mixed saliva in children. The indicators of LVH ductility in the 1st, 2nd and 3rd groups of patients at different periods of orthodontic treatment are presented in Table 1. Evaluation of the qualitative parameters of the HPV ductility of patients of the studied groups after two months of orthodontic treatment suggests that the most significant reduction in indicators (29.0 ± 1.4%) is provided by devices made of fast-hardening base plastic of the cold curing method. The minimum decrease in values (16.7±0.8%), which is most compatible with the biochemical parameters of children without dental anomalies, is achieved by using basic light-type polymerization materials. Among the published results of scientific research, there is no information about the parameters of HPV ductility, as well as their changes during orthodontic treatment in children. It can be assumed that a sharp decrease and consistent recovery of rheological parameters of NRH up to the 60th day from the start of treatment with the use of different types of curing and chemical composition of basic materials indicates an increase in the rate (volume) of unstimulated mixed saliva under the influence of hardware exposure. Modern literature data confirm that at the initial stages of orthodontic treatment there is hypersalivation on the part of the salivary glands, which supports the regulatory and mineralizing functions of saliva [14]. A systematic analysis of the results of the examination of patients in the control group suggests that type I microcrystallization prevails in NRH. The variability of the crystal content of type I ranges from 58.6 ± 2.6% to 59.8 ± 2.7%; type II – from 34.3 ± 1.6% to 35.7 ± 1.6%; type III – from 5.1± 0.2% to 7.1 ± 0.3%. The average value (type I – 59.2±2.6%; type II – 35.0±1.6%; Type III – 6.1±0.2%) was taken by us as a conditional norm, which optimally characterizes the type of microcrystallization of unstimulated mixed saliva in children. The types of microcrystallization of HPV in the 1st, 2nd and 3rd groups of patients at different periods of orthodontic treatment are presented in Table 2. A comparative analysis of the indicators of microcrystallization of HPV in patients of the studied groups after two months of orthodontic treatment allows us to conclude that the most pronounced decrease in the content of type I crystals (28.7 ± 1.4%) with a significant An increase in type III crystals (218.1±8.7%) is observed when using cold-curing devices made of fast-hardening base plastic. The minimum reduction in the level of type I crystals (16.5 ± 0.8%) with the smallest increase in the content of type III crystals (122.9 ± 6.1%), consistent with the biophysical indicators of children without dental anomalies, provides the basic materials of the light type of polymerization. The published scientific data do not provide exhaustive information concerning the ratio of microcrystal types in the NRH and their changes at the stages of orthodontic treatment in children. In our opinion, a significant increase in microcrystallization of type III mixed saliva in combination with other diagnostic signs convincingly demonstrates a higher probability of occurrence and decompensated nature of the course of the carious process of milk and permanent teeth. The combination of prognostic signs associated with a significant increase in type III microcrystals in the NRF suggests a decrease in the regulatory, mineralizing, protective and buffering functions of saliva. The results obtained by us confirm the modern scientific data of domestic and foreign researchers [17, 22]. A comparative assessment of the examination of patients in the control group allows us to establish the predominance of positive RAM on the surface of epithelial cells of the SOPR (more than 70% of epithelial cells in the smear imprint). Fluctuations in the indicators of positive RAM vary from 73.1 ± 3.7% to 74.9 ± 3.6%; negative RAM – from 25.1 ± 1.2% to 26.9 ± 1.2%. The average value of positive RAM (74.0±3.6%) and negative RAM (26.0±1.2%) of epithelial cells in the smear print was taken as a conditional norm, which objectively reflects the adhesive bacterial activity of epithelial cells of SOPR in children. The reaction of adsorption of microorganisms on the surface of the epithelial cell of the SOPR in the 1st, 2nd and 3rd groups of patients at various times of orthodontic treatment is presented in Table 3. The available results of scientific research do not allow us to form an objective assessment of the level of nonspecific resistance of epithelial cells to the adhesion ability of epithelial cells and their changes at the stages of orthodontic treatment in children. The most significant decrease in the positive FRAME (14.1± 0.7%) with a pronounced increase in the negative FRAME (40.0 ± 1.9%) is observed when using devices made of fast-hardening base plastic of the cold curing method. The minimum reduction of the positive FRAME (7.3 ± 0.4%) with the smallest increase in the negative FRAME (20.7 ± 1.1%), consistent with the biophysical indicators of children without dental anomalies, is provided by the basic materials of the light type of polymerization. In our opinion, the prognostic value of assessing the nonspecific resistance of COPD by counting the number of bacteria adsorbed on the surface of epithelial cells determines the feasibility of further scientific research in this direction. Reduction of the threshold value (70%) the adhesion activity of epithelial cells of the SOPR is probably the cause of a violation of the normal microbiocenosis of the oral cavity. This increases the risk of inflammatory or allergic reactions from the tissues of the prosthetic bed, reduces the compensatory capabilities of the microecological system, reduces the effectiveness of sanitation mechanisms, violates the physiological methods of preserving homeostasis, resulting in the development of dysbiosis. A long-term and progressive decrease in the adhesive ability of epithelial cells of the SOPR allows us to judge a significant decrease in the effectiveness of the digestive, regulatory, mineralizing, excretory, protective and buffer functions of saliva. The provisions formulated by us are confirmed by modern scientific research of domestic and foreign authors [6, 21]. Dynamic analysis of the biophysical parameters of the LVH indicates that the peak – the highest point of the phase of inflammation on the part of the dental system in response to the effect of hardware treatment occurred on the 14th day from the moment of application of orthodontic structures. On the 30-60 days, the signs of inflammation gradually disappear and the HPV indicators normalize. The restoration of the biophysical parameters of the NRH, which sets the timing of the adaptation period, is confirmed by clinical manifestations: the device is not perceived as a foreign body in the oral cavity, the feeling of discomfort decreases, there is no soreness during use, salivation is optimized. The final formation of adaptive mechanisms associated with a decrease in the parameters of ductility, microcrystallization of NRH, as well as the restoration of the adsorption capacity of epithelial cells of the SOPR, occurs with a gradual increase in the mode of use of orthodontic equipment up to 18 hours a day by the 60th day. Thus, a comprehensive assessment of biophysical indicators, such as the ductility of HPV, the reaction of adsorption of microorganisms on the surface of the epithelial cell of the SOPR, the determination of the types of microcrystals of mixed saliva, allows an objective and reliable assessment of the adequacy of adaptive reactions at the stages of removable orthodontic treatment in children using basic plastics. A systematic analysis of the biophysical parameters of mixed saliva proves that the adaptation of patients during orthodontic treatment using basic light-curing materials takes place in a shorter time compared to hardware treatment with basic cold and hot polymerization materials. This is confirmed by the optimal timing of normalization of the adhesion activity of epithelial cells of the SOPR and microcrystallization of mixed saliva, as well as by the short recovery time of the parameters of oral fluid fluidity compared with the initial values. It has

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been scientifically substantiated and clinically confirmed that adaptation to removable orthodontic equipment from basic materials for the biophysical parameters of the LVH includes two periods (phases). The first phase (from the moment of application to the 14th day) is expressed in an increase in the content of microcrystals of type III, as well as an increase in negative FRAME with a decrease in the parameters of the viscosity of unstimulated saliva . The second phase (days 14-60) is associated with the restoration of the initial biophysical parameters of NRH, as well as the normalization of the content of type I microcrystals with an increase in the adhesive activity of epithelial cells of the SOPR.

Conclusion: The obtained laboratory and clinical results of the study indicate the prospects of studying oral fluid not only in terms of clarifying its biological functions in the body and ensuring dynamic constancy of the internal environment, but also for diagnostic purposes as part of the search for new non-invasive, safe express methods aimed at improving the effectiveness and accessibility of dental care to the pediatric population.

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