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TECHNOLOGY AND THE USE OF ACRYLICS FOR PROVISIONAL DENTINE PROTECTION

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Abstract

Acrylics are compounds polymerized from monomers of acrylic, metacrylic acid or acrylonitrates. The purpose of this paper is to present the technology and use of acrylics for provisional dentine protection in the practice of dental prosthodontics. For this reason, we followed 120 clinical cases from the everyday clinical practice, divided into 4 groups of 30 patients who needed prosthetic reconstruction. The first group included cases in which we applied celluloid crowns for dentine protection, for the second group we used acrylic teeth from a set of teeth for complete dentures; in the third and fourth groups the fabrication was done with the system of an impression matrix and the acrylic resin block technique respectively. In all the examined patients, the gingival index by Silness and Loe and the vitality of the dental pulp were verified clinically, after preparation and 8 days from the placement of the provisional crown. The value for dental sensitivity measured after preparation was 2.59, and 8 days after the placement of the provisional crown it bwas 3.1. From these results we can conclude that after the 8th day from the placement of the provisional crown, there was an adaptation period, characterized by a decrease in the painful sensations. The value of the Silness and Loe gingival index measured after the preparation was 1.34, and 8 days from the placement of the provisional crown was 0.94. The results inclined us to the fact that the provisional acrylic crowns facilitated the reparation of the periodontal tissue.

Key words: acrylic compounds, technology of acrylic compounds, dentine protection, provisional crowns, polymethacrylate, polymethetilacrylate, hybrids.

Introduction

Acrylates are artificial resins obtained by merging simple chemical compounds, i.e. monomers, which results in a polymer.

The process of synthesizing individual monomer molecules into a polymer is called polymerization. As a chemical reaction, polymerization may take different routes, but the ones of interest for dentistry are additional and condensational polymerization.The additional takes place by releasing a byproduct, while with the condensational, additional products get released [5].

• General characteristics of acrylates

Like all other materials used in dentistry acrylates, among other features, primarily need to be biologically acceptable and compatible with the oral tissues. Numerous studies have shown that they are biocompatible materials that require precaution. Namely, locally there have been inflammations where they come into contact with the mucous membrane in the oral

cavity. Also, when using these materials, doctors and dental technicians have noted contact allergies. Methyl methacrylate acid, in larger concentrations, can cause respiratory disorders. Potentially toxic effects usually arise from monomers that do not bind in the process of polymerization, i.e. residual monomers. Their quantity depends on the type of acrylate and on the type of initiation. Assuming the process of polymerization was conducted properly, the percentage of residual monomers with heat-initiated polymerization is 0.2–0.5% or 1–2%. With the room temperature initiated ones the percentage is 5%. According to the ISO standards, the maximum amount of residual monomers is up to 2.2% for heat-initiated, while for room temperature it is up to 4.5%. Aside from the residual monomers, potentially irritating substances include formaldehyde, benzoyl peroxide, dibutyl phthalates, mercury salts, cadmium and others. The causes are of a physical – chemical nature, rather than allergic [6].

For an acrylic construction to be integrated it needs to have certain physical and mechanical characteristics. Acrylates are materials that have sufficient transparency, they are light, odorless and tasteless. They are easily used and repaired [7].

Acrylates do not have enough strength and hardness, and have a slightly lower abrasion resistance than desired, as well as a low level of elasticity, which makes them rugged and easier to break. They slightly absorb water (up to 2%), as a consequence of the constant release of small amounts of residual monomers. The absorbed water acts as a plasticizer and additionally compromises the mechanical characteristics of the acrylate. Solubility in water and oral fluids is of no clinical significance. Acrylates are dimensionally stable (they deform during polymerization, under the influence of solvents, heat, etc.). Porosity, i.e. the presence of tiny cavities and structures usually invisible to the naked eye, is also undesirable. Porous acrylate is prone to breaking and can also affect the colour of the construction, which reduces its aesthetic effect. Pores tend to retain food and microorganisms, which causes irritation [8].

Regardless of the aforementioned shortcomings, acrylates are still irreplaceable in their required field, and of all the dental disciplines, they find the broadest use in dental prosthetics and orthodontics. In dental prosthetics, the most commonly used are heat-initiated, while in orthodontics room temperature initiated acrylates are used [9].

• Classification and composition of acrylates

According to their basic chemical structure, these materials usually belong to the group of esters of methacrylic acid. Acrylates are two-component systems typically consisting of liquid and a solid ingredient in the form of a powder. The state of matter for the comprising parts depends on the degree of polymerization of the methyl methacrylate, i.e. the liquid is unpolymerized methyl methacrylate, while the powder is a polymer of the same chemical product – methyl methacrylate. Other substances are added to these compounds purposely [10].

The liquid, besides methyl methacrylate acid, must contain a polymerization inhibitor, whose role is to prevent possible and undesirable polymerization that can be initiated under the influence of heat or ultraviolet radiation while keeping the product. A commonly used inhibitor is 0.006% hydroquinone. The rest of the ingredients are only present in certain kinds of acrylates.

The powder, aside from the polymerized and besides methyl methacrylate acid, must also contain an initiator, plasticizer, inorganic substances and pigments. The initiator neutrallizes the effects of the inhibitor and starts the polymerization reaction. The most commonly used initiator is 0.2–1.5% benzoyl peroxide. Dibutyl and diethyl phthalate are added as plasticizers. Inorganic substances such as grains of glass, zirconium silicate and aluminum oxide improve the mechanical characteristics. The acrylates are colourless transparent materials, so they need to be coloured in order to roughly mimic tissues and organs that they are replacing in the oral cavity. For that purpose the most commonly used pigments are mercury salts, iron, cadmium and others [11].

The acrylates are most commonly classified according to the method of initiating polymerization and consistency.

1. According *to the method of initiating the polymerization:*

a. Heat-initiated polymerization, where the polymerization process is initiated and carried out by the heat in a water bath;

b. Room temperature polymerrization. Unlike the heat-initiated, these contain an accelerator that dissolves the initiator into free radicals, which activates the process of polymerization;
c. Light-initiated (photosensitive) polymerization, where the polymerization is initiated by visible light. For the needs of the polymerization, special devices are used that produce light waves with wavelengths in the spectrum of visible light with amplitudes from 380–760 nm.
d. Microwave-initiated polymerization, where the polymerization is initiated by the microwave energy of the microwave.

2. According *to the consistency of the acrylates:*
a. hard (rugged), and
b. soft (flexible);

The consistency of the acrylates depends on the amount of plasticizer in the chemical structure. Namely the soft acrylates, in addition to the usual components, contain a higher percentage of plasticizers, which is a prerequisite for their highlighted flexibility that lasts even after the polymerization process concludes. The amount of plasticizer, depending on the material, can amount up to 30%. According to the duration of the elasticity, soft acrylates are classified as conditioners and liners. With the conditioners the elasticity lasts a few weeks, while the liner's elasticity can be prolonged for up to 3 years. Over time, as a result of the evaporation of the plasticizers, the acrylates lose their elasticity and become unusable [12].

Purpose

The purpose is to present the technology and use of acrylics for provisional dentine protection in the practice of dental prosthodontics through fabrication of provisional crowns depending on their method of fabrication and the biotolerance of the vital tissues in the oral cavity.

Materials and method

For the completion of all of the aims given in this paper, we followed the condition of 120 patients from our everyday clinical practice who required the fabrication of a prosthetic construction. The necessity of a time period required for the fabrication of the definitive prosthetic construction, accompanied by the professional demand for preservation of the physical appearance in these cases, made the fabrication of dentine protection for the exposed dental surfaces essential. This was the reason for the fabrication of various types of provisional crowns in the examined patients, divided into four groups of 30 patients according to the fabrication technique and the type of provisional dentine protection. in the first group of 30 patients the dentine protection was done with celluloid provisional crowns. (Fig. 1) The celluloid provisional crowns are partly individual crowns because they are prefabricated in the shape of translucent casings that are subsequently filled with acrylic compound and clinically adapted to the exposed dentine surface. The celluloid acetate is a transparent material, used for the fabrication of translucent crowns that after the adaptation are filled with acrylic compound of the appropriate colour, previously chosen according to a colour-scale available for each synthetic material. After the finalization of the polymerization process, regardless of whether we use an auto-polymerizing acrylic compound or UV light, the celluloid casing is separated from the provisional crown and discarded while the crown is cemented onto the prepared tooth. They are available on the market in the shape of incisors, canines and premolars [3]. In the second group we used acrylic teeth from a set of teeth for complete dentures for the fabrication of provisional dentine protection. (Fig. 2) Whenever we use this technique, the provisional crowns are classified as partly individual provisional crowns. After the finished preparation of the teeth, we chose the appropriate tooth from the set of teeth for complete dentures, so as to match the one that we had just prepared. From the selected tooth we carved a casing, by drilling it with a low-speed dental handpiece. This was followed by thr use of an acrylic compound that was not required to match the colour of the teeth. With the help of the acrylic, we enclosed the tooth from the oral and the approximal sides and the encasing was put on the vestibular side. After the finished occlusion and articulation, we applied the provisional crown with dental paste for temporary cementation [1]. The third group included patients for whom the provisional acrylic crowns

were fabricated using the system of impression matrix, and this is why these crowns were classified as individual. (Fig. 3) A preliminary impression was taken before the preparation of the tooth intended for fabrication of prosthetic crown, and in this manner we preserved the form and the shape of the natural tooth. There followed the preparation method and a repeated impression following the planned phases and principles for prosthetic constructions. In this method, the fabrication of the provisional crown was initiated with the selection of an acrylic compound, only according to the scale of colours to match the teeth of the patient. The selected acrylic was mixed in a more fluid state and we applied it in the impression matrix taken before the preparation. The same impression was returned on top of the tooth isolated and prepared for crown fabrication in the oral cavity of the patient. After selective grinding of the provisional crown extracted from the impression, finishing occlusion and articulation, we applied it into the oral cavity. In the fourth group of patients, the provisional crown was fabricated using the acrylic resin block technique. (Fig. 3) The selected material was mixed until it gained the consistency of dough and then we applied it as a casing on top of the tooth isolated and prepared for crown fabrication. This was followed by selective grinding of the provisional crown, shaping the morphological characteristics of the designated tooth. The materials from which we fabricated the crowns with this technique or with the system of impression matrix differed in their chemical structure: polymethacrylates, polyethylmetacrylates, epimines and hybrids. The provisional crowns from polymethacrylates are similar in their chemical structure to the polymers from which we fabricate the complete dentures, with the exception that they are coloured with pigments the colour of the natural teeth. They require a high temperature for polymerization and because of this they have a higher degree of contraction. The stability of the colour is satisfactory, and they can be fabricated with good, highly polished edges. If they are skillfully fabricated, they can last for more than a few months. The material consists of powder – polymer and liquid – monomer. The polymer contains pigments and activator. The monomer contains inhibitor, and ground substance for greater resistance to surface abrasion. The provisional crowns made from polyethylmetacrylates have a lower temperature of polymerization and therefore are less harmful to the dental pulp. During the polymerization process, they undergo a plastic phase and because of this they are easier for manipulation and the removal of excess material from the teeth. They have low strength and resistance to abrasion. Because of the low strength they are used for the fabrication of provisional constructions with short duration. The provisional crowns from epimines have a very low temperature of polymerisation with a small contraction of the polymer and a very low quantity of residual monomer. The hybrids are different combinations of the previously-mentioned materials. In most common cases they refer to bis-acrylic composite resin. They have high strength. They are used for the fabrication of provisional bridge constructions with a large expanse. The appearance of bubbles is not rare in these materials, because of which they suck water from the oral cavity and change their colour.

Figure 1 – Provisional dentine protection with celluloid crowns (Group 1)

Figure 2 – Provisional dentine protection with a set of teeth for complete dentures (Group 2)

Picture 3 – Acrylic compounds for individual provisional dentine protection (Group 3 and 4)

In all our examined patients, we clinically verified the gingival index using Silness and Loe for gingival inflammation, and simultaneously measured the vitality of the examined tooth before, after preparation, and 8 days from the placement of the provisional crown. The measurements of the vitality or the degree of sensitivity of the dental pulp was made with an *Ispituvac zubne pulpe* P-1 dental pulp examiner. The pulp P-1 electrical dental pulp examiner is an electronic device intended for examination of the sensitivity of the dental pulp to electrical stimuli. This device produces electrical impulses with a frequency of 12 Hz, and amplitude of 1 m/sec., and the impulses produced are transmitted to the tooth by with a rubber extension of the regulator. This extension is fabricated from neutral rubber that needs to be soaked in a saline solution. The signal light serves as a control of the outcome impulses and as a referent point for reading the intensity. As charger, this device uses a standard 10 V battery of the 6-F22 – apical battery type. After switching on the regulator, contact with the exposed dentine of the tooth is established using the rubber extension of the device. The examiner of the dental pulp has electronic stabilization of the height of the outcome impulse, as well as a blockage of the impulses when the electrical potential of the battery falls below the permitted limit. While the electronic examiner is functional, it always produces the same intensity of electrical impulses, the strength of which is dependent on the intensity value set on the scale of the regulator. The gingival index of the examined tooth was measured by Silness and Loe according to the propositions for measurement, giving numerical values for the degree of inflammation for each of the surfaces of the examined tooth and dividing the value by the number of the sides of the tooth. The verified index was marked according to these gradations: 0 – healthy gums, 1 – light inflammation without bleeding, 2 – medium inflammation with provoked bleeding during dental probing, 3 – severe inflammation with unprovoked bleeding, in the same measuring periods as the vitality of the pulp.

Results and discussion

Bearing in mind that every tooth prepared for the fabrication of prosthetic construction presents an open dentine wound with exposed dentine canals and severed Tomes' fibres, it s necessary that this wound should be taken care of. The care of these teeth as described in our paper was done with the help of the fabrication of provisional crowns or a mechanical type of protection [2]. In each of the patients in the four groups we achieved function, phonation and aesthetics with the fabricated acrylic protective crowns, preserving the basic prosthodontic principles. These principles are essential for every crown regardless of whether it is provisional acrylic or definitive. As a simple, fast and economic method of fabrication, we would point to the one using the use of set of teeth from complete dentures, because very often we are left with residual teeth form these sets. In the four groups of patients, regardless of what type of dentine protection we had chosen, we came to seemingly the same results. The degree of subjective sensitivity measured immediately after the preparation showed us low values in all 120 patients. The low values indicated that the patients showed a painful reaction to a very low intensity of electrical stimulation from the electronic examiner. Namely, the prepared teeth presented an open, untreated dentine wound with severed nerve fibres that apart from the heightened degree of sensitivity are characterized by the presence of painful reaction. The degree of sensitivity of the prepared tooth during the first measurements had an average value of 2.59, and 8 days after placement of the provisional crown the average value of the examined teeth was 3.1. The degree of subjective sensitivity was measured even before preparation of the examined teeth, when the average value was 3.31. From these results we can arrive at the conclusion that 8 days after placement of the provisional crown, there occurred an adaptation

period and diminishment of the painful sensations. The value of the degree of sensitivity of the prepared teeth after 8 days is not equal to that before preparation, but compared with the value measured at the time of preparation it is satisfactory. From all of these values we can come to the conclusion that the acrylic that we used as a material for the fabrication of provisional crowns does not irritate the dentine and the dental pulp, and this is why we approve its use. (Table 1) From the results measured on the Silness Loe gingival index, we received appropriate confirmation that leads to the approval of the use of the acrylics for provisional dentine protection. On the second Silness and Loe measurement of the gingival index by, in all 120 patients (100%) we received heightened values for gingival inflammation with an average value of 1.34 that we ascribed to the physiological trauma of the gingival sulcus during the subgingival preparation. The values from the third measurement, 8 days after the application of the provisional crowns, had an average value of 0.94, which led us to the fact that the provisional acrylic crowns facilitate the reparation of the periodontal tissue. (Table 2)

The dentine canals and the severed nerve fibres are indifferent to the presence of the acrylic compound in their vicinity, which we realized based on the received subjective responses from the patients that they did not feel pain after the application of the provisional crown.

Table 1

Measured values of degree of sensitivity of examined teeth

Examined patients divided into groups	Measured values for the degree of sensitivity of the examined teeth before preparation	Measured values of the degree of sensitivity of the examined teeth after preparation	Measured values of the degree of sensitivity of the examined tooth, 8 days from placement of the provisional crown
First group of patients	3.27	2.6	3.13
Second group of patients	3.30	2.59	3.1
Third group of patients	3.35	2.59	3.07
Fourth group of patients	3.32	2.58	3.1
Average values of the examined teeth in the four groups	3.31	2.59	3.1

Table 2

Measured values of gingival index of the examined teeth according to Silness and Loe

Examined patients divided into groups	Measured values of S L gingival index of examined teeth before preparation	Measured values of S L gingival index of examined teeth after preparation	Measured values of S L gingival index 8 days after placement of provisional crown
First group of patients	0.48	1.35	0.93
Second group of patients	0.59	1.32	0.91
Third group of patients	0.50	1.36	0.95
Fourth group of patients	0.55	1.33	0.97
Average values of examined teeth in the four groups	0.53	1.34	0.94

Conclusion

Based on the received findings regarding the technology and use of acrylics for provisional dentine protection, we arrived at the following conclusions:

1. The everyday use of acrylics for provisional dentine protection as a mechanical protection of the prepared teeth is absolutely justified;

2. The selection of the type and technique of fabrication for the provisional protective crown from acrylic has no influence on the preservation of the health of the dentine and the periodontium;

3. We concluded that not only does the provisional dentine protection participate in the preservation of the vitality of the dental pulp, but it also facilitates the process of reparation of the periodontium.

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Резиме

ТЕХНОЛОГИЈА И УПОТРЕБА НА АКРИЛАТНИ МАСИ ЗА ПРИВРЕМЕНА ДЕНТИНСКА ЗАШТИТА

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Акрилатите се полимерни соединенија, добиени со полимеризација на мономери од акрилна, метакрилна киселина или акрилонитрати. Целта на трудот е да се прикаже технологијата и употребата на акрилатните маси за привремена дентинска заштита во стоматолошката протетичка практика. Во таа насока беа проследени 120 пациенти, поделени во 4 групи од по 30 пациенти од секојдневната клиничка практика, кои имаа потреба од изработка на фикснопротетички конструкции. Првата група беа оние на кои дентинската заштита ја изведуваме со целулоидни коронки. Кај втората група за изработка на привремената дентинска заштита користевме акрилатни заби од гарнитура заби за тотални протези. Третата група беа пациентите кај кои заштитните акрилатни коронки ги изработувавме според методот на копир систем. Во четвртата група на пациенти, привремената заштита ја изработувавме по системот на блокче. Кај сите испитувани пациенти клинички го верифицираме гингивалниот индекс според Silness и Loe за гингивална инфламација, а истовремено го меревме и виталитетот на испитуваниот заб, по препарација и по 8 дена од носењето на привремената коронка, при предавањето на дефинитивната протетичка конструкција. Измерената вредност на степен на осетливост на испитуваниот заб по препарацијата изнесуваше 2,59, а 8 дена од носењето на привремената

коронка 3,1. Од овие резултати можеме да дојдеме до сознание дека по 8 дена од носењето на привремената коронка, настанал период на адаптација и намалување на болните сензации. Измерената вредност на гингивалниот индекс според Silness и Loe по препарација изнесуваше 1,34, а 8 дена од носењето на привремената коронка 0,94. Резултатите ни укажаа на фактот дека привремените акрилатни коронки ја потпомогнале репарацијата на пародонталното ткиво.

Клучни зборови: акрилатни маси, технологија на акрилати, дентинска заштита, привремени коронки, полиметилакрилат, полимететилакрилат, хибриди.