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AKRILATI - JOŠ UVEK NEZAMENLJIVI MATERIJALI U STOMATOLOŠKOJ PROTETICI

ACRYLIC RESINS – STILL IRREPLACABLE MATERIALS IN PROSTHETIC DENTISTRY

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Kratak sadržaj

U radu su, na osnovu podataka iz dostupne literature, opisani hemijski sastav, klasifikacija, kao i primena akrilata u stomatoprotetskoj praksi. Pored toga, prezentirane su osnovne karakteristike akrilata, sagledane sa aspekta prednosti, odnosno nedostataka, a sve radi njihovog adekvatnog izbora u uslovima kliničko - laboratorijskog rada.

***Ključne reči**: akrilati, stomatološka protetika*

Summary

Based on the data from the available literature, in this study are presented basic characteristics of acrylic resins perceived through the aspect of advantages and disadvantages and their adequate choice in the condition of clinic – laboratory practice. Also, the chemical composition, classification and acrylic resins application in prosthodontic practice have been described.

***Key words:** acrylic resins, prosthetic dentistry*

Uvod

Akrilati su veštačke smole koje se dobijaju sjedinjavanjem jednostavnih hemijskih jedinjenja, tzv. monomera, pri čemu kao produkt te sinteze nastaje polimer.

Proces sinteze monomernih molekula u polimer naziva se polimerizacija. Kao hemijska reakcija, polimerizacija može teći različitim tokovima, ali za stomatologiju su od interesa adiciona i kondenzaciona polimerizacija. Adiciona se odvija bez oslobađanja nusproizvoda, dok se pri kondenzacionoj polimerizaciji oslobađaju nusproizvodi (npr. voda, vodonik hlorid i dr.).

Cilj rada

Cilj rada bio je da prikaže osnovnu hemijsku strukturu, karakteristike, kao i primenu akrilata u stomatološkoj protetici.

Introduction

Acrylic resins are the artificial resins obtained through the fusion of plain chemical compounds so-called monomers, having a polymer as the product of that synthesis.

The process of monomer molecules synthesis into the polymer is called polymerization. Polymerization, as a chemical reaction can go in a different courses, but dentistry is interested in additional and condensational polymerization. Additional goes without releasing side products, whereas in the process of condensational polymerization side products are being released (water, hydrogen chloride, etc.). Acrylic resins are polymerized by additional reaction.[1]

The **aim** of this study was to illustrate the basic chemical structure, characteristics and the acrylic resins application in dental prosthetics.

Prema osnovnoj hemijskoj strukturi, ovi materijali najčešće pripadaju estrima metakrilatne kiseline.[1] U stomatologiji se koristi više estara metakrilatne kiseline, ali najširu primenu ima metilmetakrilat (MMA). Akrilati su dvokomponentni sistemi koji se sastoje iz tečnog dela i čvrstog, koji je u obliku praška. Agregatno stanje komponenata (tečnosti i praška) određeno je stepenom polimerizacije MMA, kao osnovne supstance. Naime, tečnost je nepolimerizovani MMA, odnosno monomer, dok je prašak polimerizat metilmetakrilata (PMMA), tj. polimer.[2] Ovim materijama namenski su dodate i druge supstance.

Tečnost, pored MMA, obavezno sadrži inhibitor polimerizacije, čija je uloga da spreči eventualnu neželjenu, polimerizaciju koja može da se inicira pod dejstvom toplote ili ultravioletnog zračenja tokom skladištenja preparata. Kao inhibitor najčešće se koristi 0.006% hidrohinon. Ostali sastojci (umreživač, akcelerator) prisutni su samo u pojedinim vrstama akrilata.

Prašak, pored PMMA, ima u svom sastavu inicijator, plastifikator, anorganske supstance i pigmente. Inicijator neutrališe dejstvo inhibitora i pokreće reakciju polimerizacije. Za ovu svrhu koristi se obično benzoilperoksid u količini 0.2 - 1.5%. Dibutil i dietil ftalat se akrilatima dodaju kao plastifikatori. Anorganske supstance, kao što su zrnca stakla, cirkonijum silikata, aluminijum oksida, doprinose poboljšanju mehaničkih karakteristika. Akrilati su prozračne, bezbojne materije koje je potrebno obojiti kako bi približnije imitirale tkiva i organe usne duplje koje zamenjuju. Kao pigmenti koriste se soli žive, gvožđa, kadmijuma i dr[3].

Akrilati se najčešće ***klasifikuju*** *prema načinu iniciranja polimerizacije i konzistenciji.*

I Prema načinu iniciranja reakcije polimerizacije:[3,4]

1. Toplopolimerizujući akrilati su oni kod kojih se proces polimerizacije inicira i odvija pod dejstvom toplote u vodenom kupatilu.

2. Hladnopolimerizujući akrilati polimerizuju se na sobnoj temperaturi. Za razliku od toplopolimerizujućih, sadrže akcelerator, koji razlaže inicijator polimerizacije na slobodne radikale, čime se aktivira proces polimerizacije. Kao akcelerator koristi se amindimetiparatoluidin.

3. Svetlosnopolimerizujući (fotosenzibilni) akrilati su oni kod kojih je vidljiva svetlost

According to their basic chemical structure, these materials most commonly belong to the esters of methacrylate acid. Several methacrylate acid esters are used in dentistry, but the wider appliance has the methyl methacrylate (MMA). Acrylic resins are dual component systems consisting of liquid and solid part in the form of powder. Aggregation state of the components (powder and liquid) has been determined by the MMA polymerization degree as a basic substance. Namely, liquid is a non-polymerized MMA - monomer, while the powder is polymeric methyl methacrylate (PMMA) – polymer[2]. Other substances have been intentionally added to these materials.

In addition to MMA, liquid compulsory contains polymerization inhibitor having a role of preventing eventual, unwanted polymerization initiated by the heat or ultraviolet ray effect during the period of storage. A 0,006% of hydrochinon is most commonly used as an inhibitor. Other ingredients like (cross linker, accelerator) are present only in a certain types of acrylic resins.

Powder, along with the PMMA, in its composition, has initiator, plasticizer, inorganic substances and pigments. Inhibitor's effect is neutralized with the initiator and starts the polymerization reaction. For this purpose usually is used benzoyl peroxide in the quantity of 0.2 – 1.5%. During the polymerization plasticizer (dibutil phthalate) is added with the aim to increase the elasticity of the acrylic resin. Inorganic substance like glass fibres, zirconium silicate, aluminium oxide, are contributing the mechanical characteristics improvement. Acrylic resins are translucent, colourless matters that need to be coloured in order to imitate the replacing tissues and organs of oral cavity more closely. The salts of mercury, iron and cadmium are used as pigments[3].

Acrylic resins are usually classified:

I As per initiating polymerization reaction mode[3, 4]:

Heat/polymerized are the acrylic resins by whom the polymerization process is initiated and unfolds under the heat effect in the water bath.

Cold/polymerized are the acrylic resins polymerized at room temperature. Unlike heat/polymerized, cold/polymerized acrylic resins contain accelerator for decomposing polymeri-

aktivator polimerizacije. Za potrebe polimerizacije koriste se specijalni aparati koji proizvode vidljivu svetlost talasne dužine dijapazona Λ= 380-760 nm.

4. Mikrotalasnopolimerizujući akrilati očvršćavaju pod dejstvom energije izazvane mikrotalasima u mikrotalasnim pećima.

II Prema konzistenciji:

Akrilati mogu biti tvrdi (krti), odnosno meki (fleksibilni).[5]

Konzistencija akrilata zavisi od količine plastifikatora u hemijskoj strukturi. Naime, meki akrilati, pored uobičajenih komponenti, sadrže veći procenat plastifikatora, što uslovljava njihovu izraženiju fleksibilnost i nakon završenog procesa polimerizacije. Količina plastifikatora se, u zavisnosti od preparata, kreće i do 30%.[6] Prema vremenu trajanja elastičnosti meki akrilati dele se na kondicionere i lajnere. Kod kondicionera elastičnost traje nekoliko nedelja, dok se kod lajnera taj period prolongira i do 3 godine.[3] Vremenom, usled isparavanja plastifikatora, akrilati gube elastičnost i postaju neupotrebljivi.

Karakteristike *akrilata*

Kao i svi gradivni materijali koji se koriste u stomatologiji, pored ostalih karakteristika, prvenstveno treba da budu biološki prihvatljivi, odnosno da su kompatibilni sa oralnim tkivima. Brojna istraživanja ukazuju da se radi o biokompatibilnim materijalima, kod čije primene je potreban oprez. Naime, na lokalnom nivou uočena je inflamacija na mestima gde akrilat dolazi u kontakt sa sluzokožom usne duplje (slika 1).[7,8]Takođe, u radu sa ovim materijali-

zation initiator to free radicals thus activating the process of polymerization. The amine dimethyl paratholuidin is used as an accelerator.

Light/polymerized are the acrylic resins by which the polymerization is activated by the visible light. Special devices producing visible light are used for the needs of polymerization with diapason of Λ=380-760 nm.

Microwave/polymerized acrylic resins are hardening if exposed to the microwave irradiation.

II As per its consistency:

Acrylic resins can be hard (fragile), that is soft (flexible).[5]

They are mutually different by the quantity of plasticizer in the chemical structure. Beside the usual components, soft acrylic resins contain higher percentage of plasticizer thus causing their flexibility after the polymerization process has actually finished. Depending on the preparation, plasticizer quantity varies even up to 30%.[6] According to the duration period of elasticity; soft acrylic resins are divided to the conditioners and liners. Conditioners' elasticity endures several weeks, while the liners prolong that period up to 3 years.[3] Gradually, due to the evaporation of plasticizer, they are loosing elasticity and becoming unusable.

Acrylic resins' ***characteristics***

All materials used in dentistry should in the first place be biologically acceptable, that is compatible with the oral tissues. Numerous research works are pointing out that it is about biocompatible materials whose application demands caution. It's been noticed that locally, in

Slika 1. Inflamacija oralne sluzokože prouzrokovana rezidualnim monomerom
Figure 1. Inflamation of oral mucosa caused by residual monomer

Slika 2. Alergijski kontaktni dermatitis nastao u direktnom kontaktu alergena (monomera akrilata) i kože
Figure 2. Allergic contact dermatitis caused in direct contact of allergen (acrylic monomer) and skin

ma, od strane lekara, odnosno zubnih tehničara, opisana je kontaktna alergija (slika 2).[9,10] MMA može u većim koncetracijama provocirati izvesne respiratorne poremećaje.[11] Potencijalno toksični efekti najčešće potiču iz monomera koji se nije vezao tokom procesa polimerizacije (tzv. rezidualni monomer). Njegova količina zavisi od vrste akrilata i načina izvođenja polimerizacije.[12,13] Pod pretpostavkom da je režim polimerizacije izveden pravilno, procenat rezidualnog monomera kod toplopolimerizujućih akrilata kreće se od 0,2 - 0,5% odnosno 1 - 2%. Kod hladnopolimerizujućih akrilata ta količina iznosi i do 5%. Prema standardu (ISO 1567:1999) maksimalno dozvoljena količina monomera za toplopolimerizujuće akrilate je 2,2%, a za hladnopolimerizujuće akrilate 4,5%.[14] Osim rezidualnog monomera, kao potencijalno iritirajuće supstance mogu delovati i formaldehid, benzoil peroksid, dibutil ftalat, soli žive, kadmijuma i dr.[15,16] Uzroci iritacija više su fizičko - hemijske nego alergijske prirode.

Akrilati su materijali koji imaju zadovoljavajuću transparenciju, malu specifičnu težinu, bez mirisa su i bez ukusa. Jednostavno se obradjuju i repariraju. Da bi se neka protetska nadoknada od akrilata integrisala u stomatognati sistem, neophodno je da, između ostalog, poseduje odgovarajuće mehaničke i fizičke karakteristike. Može se reći da ove njihove osobine nisu na željenom nivou.[17,18] Naime, akrilati nemaju potrebnu čvrstoću i tvrdoću, poseduju nešto nižu otpornost na abraziju od željene, kao i manji modul elastičnosti, što ih čini krtim i lakše lomljivim. Skloni su da neznatno apsorbuju vodu (do 2%), što je posledica konstantnog oslobađanja malih količina rezidualnog monomera. Apsorbovana voda deluje kao plastifikator i eventualno dodatno kompromituje mehaničke osobine.[19] Njihova rastvorljivost u vodi i oralnim tečnostima slaba je i nema klinički značaj.

Akrilati nisu dimenzionalno stabilni materijali (deformišu se za vreme polimerizacije, dejstvom rastvarača, zagrevanjem) i dr.[1]

Poroznost, odnosno prisustvo sitnih, obično golim okom nevidljivih šupljina u strukturi ovih materijala, takođe je nepoželjna. Porozan akrilat sklon je prelomu, a može da utiče i na promenu boje nadoknade, čime se umanjuje njen estetski efekat. Pore su predilekciono mesto za retenciju hrane i mikroorganizama, zbog čega iritativno dejstvo akrilata može biti naglašenije.

the places where acrylic resin is directly contacting the mucous of the oral cavity, an inflammatory process appears (figure 1).[7,8] Also, in everyday practice of doctors, dental technicians a contact allergy has been described (figure 2).[9,10] MMA can, in higher concentrations provoke certain respiratory disorders.[11] Potentially toxic effects are originating from the monomer who did not bind during the polymerization process (so-called residual monomer). Its quantity depends of the type of acrylic resin and polymerization performance pedantry.[12,13] Assuming that the polymerization regime has been performed accurately, the percentage of the heat/polymerized residual monomer goes from 0,2 - 0,5 that is 1 - 2%. With the cold/polymerized t acrylic resin hat quantity amounts up to 5%. Maximum allowed monomer quantity for the heat/polymerized acrylic resins according to the standard (ISO 1567:1999) is 2,2%, and for the cold/polymerized acrylic resins is 4,5%.[14] Besides the residual monomer, as potentially irritating substance, the formaldehyde, benzoic peroxide, dibutil phthalate, salts of mercury, cadmium, etc. can act as well.[15,16] Irritations caused are physically –chemical rather than of allergy nature. Acrylic resins are the materials with the satisfying transparency, small specific volume, odourless and no taste. They are treated and repaired easily.

In order to integrate some acrylic resins prosthetic dentures in the orofacial system, it is necessary among other that it possesses appropriate mechanical and physical characteristics. One can say that these features of acrylic resins are not at the desired level.[17,18] Acrylic resins do not possess necessary hardness and firmness; they possess a bit lower resistance to the abrasion, than desired and smaller elasticity module which makes them fragile. They are prone to absorb water which is the consequence of constant release of residual monomer small quantities. Absorbed water works as plasticizer and eventually compromises the mechanical features additionally[19]. Their solubility in water and oral liquids is weak and has no clinical significance.

Acrylic resins are dimensionally stabile materials (they are deformed during the polymerization, by solvents impact, heating) etc.[1]

Porosity, the presence of small, invisible by the eye, cavities in the structure of these materials is also not desirable. Porous acrylic resin is prone to fracture, and can also influence the

Takođe, kontrakcija i ekspanzija koje se dešavaju tokom procesa polimerizacije predstavljaju potencijalni uzrok napona unutar samog materijala. Posledice oslobađanja unutrašnjeg napona mogu se manifestovati povećanom osetljivošću protetske nadoknade na prelom. Sva ova svojstva variraju unutar samih grupa, što je rezultat neznatnih razlika u hemijskoj strukturi, homogenosti akrilatne smeše, a ponajviše u režimu polimerizacije.[20,21]

Bez obzira na pomenute nedostatke, još uvek su nezamenljivi za svoje indikaciono područje, a od svih stomatoloških disciplina imaju najširu **primenu** u stomatološkoj protetici.

Kao gradivni materijali akrilati se koriste u izradi baza pločastih mobilnih zubnih proteza (primena datira još od 1937. godine)[22], veštačkih zuba, faseta krunica i mostova, privremenih fiksnih zubnih nadoknada, kao i za potrebe podlaganja i reparatura nadoknada, napravljenih od ove vrste materijala.

Kao pomoćni materijali, akrilati se upotrebljavaju za izradu individualnih kašika, zatim modela pojedinih zubnih nadoknada, nagriznih grebena, eventualno baznih ploča i zagrižajnih bedema. Pojedine formule MMA učestvuju u strukturi nekih materijala za trajno vezivanje fiksnih zubnih nadoknada (cementi na bazi smola i glas-jonomer cementi modifikovani smolama).[23,24]

Za razliku od krutih, meki akrilati se koriste za podlaganje baza pločastih zubnih proteza, privremenog ili trajnog karaktera, u strogo definisanim indikacijama, zatim u izradi obturator i maksilofacijalnih proteza.[25]

Zaključak

Kao i ostali materijali koji se koriste u stomatologiji, ni akrilati nisu savršeni i malo je verovatno da će takav ideal biti ostvaren. Postojeći akrilati imaju izvesna ograničenja, ali iskorišćeni u punom potencijalu, zauzimaju značajno mesto u stomatoprotetskoj praksi. Može se reći da njihov adekvatan izbor, pedantan postupak polimerizacije i odgovarajuća obrada protetskog rada, uz sve to i korektna oralna higijena predstavljaju odlučujuće faktore uspeha i dugovečnosti protetskih nadoknada načinjenih od ove vrste materijala.

colour of the dentures disparaging it aesthetic effect.

Pore is a predilection place for food retention and micro organisms due to which irritating influence of the acrylic resins can be more stressed.

The contraction and expansion during the polymerization process can also present the potential cause of tension in the material itself. The consequences of inner tension releasing can be manifested in higher sensitivity of prosthetic compensation to the fracture.

All these characteristics vary within the groups itself as a result of insignificant differences in chemical structure of acrylic resins homogeneity and mostly in the polymerization regime.[20, 21]

Regardless to the mentioned disadvantages, they are still irreplaceable for its indicative areas and have the wider application in dental prosthetics from all dentistry disciplines.

Acrylic resins as materials are used in processing mobile dentures bases (application dates back in 1937)[22], artificial teeth, facet crowns and dental bridges, temporary fixed dentures, as well as for needs of reline and dentures reparations.

As supplementary these materials are used for the individual spoon, certain dentures models, occlusal bite, eventually base plates and occlusal rims. Certain MMA formulas are participating in the structure of some materials for permanent bonding of fixed dentures (resin based cement and glass ionomer cements modified by resins).[23,24]

The soft acrylic resins, unlike hard ones, are being used for reline denture base temporary or of permanent character in strictly defined indications, and further in the processing of obturator and maxillofacial prosthesis.[25]

Conclusion

The acrylic resins, like other materials used in dentistry are not perfect and it is little likely to accomplish an ideal of perfection. The existing acrylic resins are prone to a certain limitations, but utilized in full potential still take the important place in dental prosthetics. One can say that adequate choice of, acrylic resins pedantic polymerization treatment and appropriate prosthetic work processing, along with the correct oral hygiene present determining factors for success and durability of prosthetic dentures made of this kind of material.

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