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APPLICATION OF HIGH PERFORMANCE POLYMERS IN PROSTHETIC RESTORATION ON IMPLANTS

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Abstract: For prosthetic hybrid restorations on implants, different combinations of materials are used, from metal alloys, titanium, ceramics, polymers or composites. The aim of this paper is to summarize the characteristics and advantages of certain polymers in the production of hybrid restorations, as well as to present the protocol for treating patients with this type of restoration. Polymers based on poly-ether-ether-ketone have gained great popularity and success in the field of implant-prosthetic therapy. Among them, the most famous high-performance polymers developed by Bredent (Bredent group, Senden Germany) are BioHPP (containing 20% ceramic fillers) and breCAM.HIPC (highly cross-linked polymer composite material). Both polymers are machinable and are used to make temporary and permanent resaturations in prosthetics. They are biocompatible and non-allergenic, do not contain metal, oxide and monomer components, and also do not discolor the gingiva. They are characterized by excellent workability and elasticity, which is greater than zirconium ceramics and metal alloys, different shades of color is characteristics for breCAM.HIPC, unlike BioHPP, which is monolithic and monochromatic. Due to their characteristics, these high-performance polymers can be exceptional "allies" for the restorations on implants

Keywords: polymers, implants, BioHPP, breCAM.HIPC.

1. INTRODUCTION

Prosthetic rehabilitation of edentulous patients with conventional dental prostheses has a large number of disadvantages, starting from reduced masticatory efficiency, frequent occurrence of decubitus lesions on the oral mucosa, the need for underlayment, to the fact that the absence of stimuli from natural teeth leads to bone tissue resorption [1]; The aforementioned defects can significantly impair the quality of life of edentulous patients, so it is not surprising that clinicians resort to the creation of hybrid restorations supported by implants, at the level of multi-unit abutments.

The advantage of using a multi-unit abutment is the possibility of correcting different implant heights and correcting the angle of the implant, establishing a flat restorative platform for a hybrid restoration, as well as the possibility of raising the implant connection as close as possible to the gingival surface, while the removal of the restoration itself is simplified. Considering the time and resources that clinicians and patients invest in the rehabilitation of edentulous jaws with implant-supported restorations, multi-unit abutments represent a modest investment in an efficient, accurate, and predictable restoration [2,3]. One of the doubts that arise for clinicians when making such restorations is certainly the choice of material.

For hybrid restorations, different combinations of materials are used, from metal alloys, titanium, ceramics, polymers, or composites. The advantages and disadvantages of metal alloys and ceramic materials in terms of physical-mechanical characteristics and financial moment are known, considering that these materials have been used in prosthetics for many years [4].

2. HIGH PERFORMANCE POLYMERS

Despite the successful application of poly-methyl-meth-acrylate (PMMA) and resin-based composites in conventional prosthetics, high-density polymers, and polymer composites have great popularity and success in implant-prosthetic therapy. The first polymer that was developed to replace metals and weaker polymers in fixed and mobile dental restorations is the so-called poly-ether-ether-ketone (PEEK) from the group of poly aryl ether ketones (PAEK) [5].

The first company in the world that used PEEK-based polymers as a material for making frameworks, i.e. the basics of dental restorations, is Bredent (Bredent group, Senden Germany). BioHPP is exactly that type of polymer developed by Bredent and belongs to high-performance polymers reinforced with 20% ceramic fillers, based on aluminum and zirconium oxide [6]. Ceramic fillers are added with the aim of improving mechanical characteristics, higher degree of polishing of the material, reduction of plaque retention, as well as longer color stability. It is considered a universal material for making the framework for fixed, mobile, and implant-supported prostheses. Treatment with BioHPP significantly reduces chewing forces, i.e. compression and torsion, and partially compensates them unlike titanium or ceramic, which results in a pleasant feeling for the patient, less functional disturbances or technical complications, and also protects the implants during the period of osseointegration. It belongs to biocompatible and non-allergenic materials, does not contain metal oxide, and monomer components, and does not discolor the gingiva. It is significant that it does not lead to the appearance of a metallic taste in the mouth and there is no difference in the perception of temperature changes compared to natural teeth [4,6].

Another type of polymer-based material developed by Bredent after BioHPP is breCAM.HIPC for making temporary or permanent restorations with long-term success. Both polymers are made as machinable materials and are applied using subtractive, ie. CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) technologies.

The so-called "High Impact Polymer Composite" (HIPC) represents an amorphous, chemically inert, highly cross-linked polymer composite material, therefore it has better characteristics compared to conventional PMMA [7]. It is often mixed with PEEK ie. BioHPP, because both materials have greater elasticity when compared to zirconia ceramics or metal alloys. On the other hand, the hardness of BioHPP is higher compared to breCAM.HIPC, which makes BioHPP more difficult to process, finish and adhere to aesthetic materials used for veneering and characterization.

breCAM.HIPC features are excellent workability, elasticity, and the possibility to choose different shades of color found among VITA samples, unlike BioHPP which is monolithic and monochromatic and does not offer a choice of color keys. It is produced under conditions of elevated temperature of 120°C and under pressure of 250 bar. The fact is that breCAM.HIPC plaque is resistant and has excellent compatibility with the gingiva as well as color fastness, translucency, and opalescence, similar to direct ceramic veneers and pressed ceramics. Restorations made using breCAM.HIPC can be monolithic or can be subsequently faceted [8,9].

Compared to ceramics, HIPC shows long-term stability, i.e. it is not subject to so-called aging, which is particularly characteristic of zirconia ceramics. The increased elasticity of the material, combined with the fact that it can be monolithic, leaves out the possibility of the occurrence of the problem of breakage and delamination, the so-called chipping which is characteristic of ceramics [10]. It is this long-term stability and reliability of the material itself that leads to less need for replacement repairs, and increases the final quality of work.

When restorations are made of zirconium or layered ceramics and there is a need for ceramic repair as a result of its delamination, it is more difficult, unlike HIPC repair, which is simplified.

The basic characteristics of BioHPP and breCAM.HIPC materials are given in Table 1, and their indications in prosthetics according to the manufacturer's instructions are given in Table 2.

Table 1. *Polymer characteristics (Bredent)*

Type of material	Modulus of elasticity	Flexural strength	Solubility in water	Water absorption	Residual monomer	Type of restoration (longevity)
BioHPP	>4550 MPa	> 180 MPa	<0,3 µm/mm³	<6,5 µm/mm³	≤ 0,5%	Permanent – more years
BreCAM.HIPC	>2200 MPa	> 120 MPa	<0,3 µm/mm³	<16 µm/mm³	≤ 0,5%	Permanent

Table 2. *Indications according to the manufacturer*

Indication	BioHPP	breCAM.HIPC
Crowns	✓	✓
Bridges, no more than 2 crowns	✓	✓
Crowns and bridges on implants	✓	✓
Primary double crowns	✓	✓
A framework of removable partial dentures	✓	✓
Second double crowns	✓	✓
Toronto bridges	✓	×
Inlays, onlays	×	✓
Veneers	×	✓
Framework for implant restorations	✓	✓
Monolith implant restorations	×	✓

3. CASE REPORT

A 79-year-old patient came in for prosthetic treatment of toothlessness in the upper and lower jaw. After the implant placement intervention and confirmed osseointegration of the implants in the upper and lower jaw, 4 months after the treatment, the creation of a hybrid restoration in the upper and lower jaw was started. The material of choice is breCAM.HIPC and is supported by a bar made of cobalt-chromium alloy (Co-Cr).

3.1. Work protocol (clinical phases)

1) Impression at the multi-unit abutment level digital/analog impression

2) Determination of inter-jaw relationships/ determination of tooth color

3) A. Checking of the metal construction (crossbars) with mandatory control of the accuracy of the bar – Figure 1.

B. Connecting the metal structure to the polymer and the polymer sample - Figure 2.

4) Checking of monolithic HIPC/Determining the color of the gingiva – Figure 3.

5) Cementation of dental restoration- Figure 4.

6) Inspections/protection of the multi-unit abutment screw with Teflon tape and filling the holes with composite

Figure 1. *Checking of the metal construction (crossbars) with mandatory control of the accuracy of the bar*

Figure 2. *Connecting the metal structure to the polymer and the polymer sample*

Figure 3. *Checking of monolithic HIPC/Determining the color of the gingiva*

Figure 4. *Finishing and cementation of dental restoration*

3.2. Work protocol (laboratory phases)

1) Virtual restoration design

2) Making a bite template

3) 3D printing of metal structures and production of polymers by 3D printing

4) CAD/CAM production of monolithic HIPC, cut-back technique

5) Faseting the vestibular surface of the restoration with composites

6) Glazing of the restoration

Due to unpreserved proprioceptor impulses and possible parafunctional activities, it is recommended to make a protective splint in patients with this type of restorations.

4. CONCLUSION

High-performance polymers can be an exceptional "ally" in the production of restorations on implants due to the resin component and lower hardness, which would amortize possible traumas of the peri-implant soft tissue or antagonists, which may occur due to the development of greater forces during chewing.

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ПРИМЕНА ПОЛИМЕРА ВИСОКИХ ПЕРФОРМАНСИ У ИЗРАДИ ЗУБНИХ НАДОКНАДА НА ИМПЛАНТИМА

Сажетак: У изради хибридних надокнада на имплантима користе се различите комбинације материјала, од легуре метала, титанијума, керамике, полимера или композита. Циљ овог рада је сумирање карактеристика и предности одређених полимера у изради хибридних надокнада, као и приказ протокола у збрињавању пацијената овом врстом надокнада. Полимери на бази поли-етер-етер-кетона стекли су велику популарност и успешност на пољу имплантно-протетске терапије. Међу њима најпознатији полимери високих перформанси које је развио Бредент (Bredent group, Senden Germany) су BioHPP (садржи 20% керамичких пуниоца) и breCAM.HIPC (високо умрежени полимерни композитни материјал). Оба полимера су машински обрадива и користе се у изради привремених и трајних ресатурација у протетици. Спадају у биокомпатибилне и неалергогене материјале, не садрже металне, оксидне и мономерне састојке, а такође не пребојавају гингиву. Карактерише их одлична обрадивост и еластичност која је већа од цирконија керамике и легура метала, а breCAM.HIPC и могућност избора различитих нијанси боје, за разлику од BioHPP-а који је монолитан и једнобојан. Због својих карактеристика полимери високих перформанси могу бити изузетни „савезници“ у изради надокнада на имплантатима.

Кључне речи: полимери, импланти, BioHPP, breCAM.HIPC.

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