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Review article

POSSIBLE APPLICATION OF BIOHPP IN PROSTHETIC DENTISTRY: A LITERATURE REVIEW

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ABSTRACT:
Purpose: The aim of this presentation is to summarize the clinical applications of BioHPP (High Performance Polymer) for removable and fixed restorations.

Materials and methods: A critical survey was conducted among 299 literature sources related to PEEKs and in particular with BioHPP.

Results and discussion: According to the literature in this field the mechanical properties (in particular its elasticity) of BioHPP are closer to those of the dental tissues, and this fact gives an advantage of this material compared to the metal alloys and the ceramics. A variety of procedures have been suggested to condition the surface of BioHPP in order to facilitate its bonding with resin composite cements. In the Prosthetic Dentistry BioHPP is widely used for fixed and removable restorations frameworks fabrication by pressing and by CAD/CAM technology.

Conclusion: Nowadays investigations for new abilities of BioHPP use in Prosthodontics are conducted. They are based on combined alternative fixed restorations made of PEEKs and metal alloys.

Keywords: BioHPP, applications, Prosthetic Dentistry, literature review

INTRODUCTION:

The purpose of this publication is to summarize the application of PEEK and in particular of BioHPP in Prosthetic Dentistry. PEEK (polyetheretherketone) is the most significant representative of polyaryletherketone (PAEK). This is a partially crystalline, thermoplastic high temperature-resistant high-performance plastic with a melting temperature of approximately 334°C. Therefore, PEEK can be used in pressurized compression systems like "for 2 press" system, while the factory pressed product can be processed with different cutters and used in CAD/CAM technology.

BioHPP (High Performance Polymer) is a part of the PEEK family and is applied in surgical procedures for years. As a result of its excellent stability, its optimal polishing properties and its low plaque affinity, BioHPP is very good for precise prosthetic restorations fabrication. The biopolymer has a modulus of elasticity closer to the human bone and this fact improves the chewing pressure transmission.

MATERIALS AND METHODS:

A survey based on 299 literature sources from Bulgarian authors and foreign authors from PubMed and

Science Direct was made. We used a combination of keywords: "polyetheretherketone", "dentistry", "BioHPP" in the PubMed (Medline) database.

RESULTS AND DISCUSSION.

Polyetherketone (PEEK) is a synthetic polymeric material that was applied in medical orthopaedics for years [1, 2].

Two decades ago, after confirming their biocompatibility, PAEKs were increasingly used as biomaterials for orthopaedic trauma and spinal implant production [3]. PAEK is a relatively new family of high temperature thermoplastic polymers consisting of a basic aromatic molecular chain linked together by ketone and ether functional groups. The chemical structure of polyaromatic ketones gives stability at high temperatures (over 300 ° C), making it extremely attractive for industrial applications. By the end of 1990, PEEK had emerged as the main thermoplastic polymer and was used to replace metal components in the orthopaedics [4].

PEEK can easily be modified by including other materials. For example, carbon fiber insertion may increase the elastic modulus to 18 GPa. The carbon-reinforced PEEK module is also comparable to this of the cortical bone and the dentin. The tensile strength of PEEK is similar to that of bone, enamel and dentin, making it an optimal material for permanent prosthetic restorations [5].

Unlike titanium, PEEK has limited osteogenic properties. This is the reason for the fact that a significant part of the studies is related to the increasing of the biological activity of REEK implants. There are a number of methods that have been proposed for improving the bioactivity of PEEK - coating with synthetic osteogenic hydroxyapatite, increasing the surface roughness and chemical modifications with bioactive particles addition [6].

Bioactive PEEK with ceramic filler – BioHPP

BioHPP (High Performance Polymer) is a high-tech thermoplastic polymer based on PEEK. It was created

and optimized for dental use. It contains ceramic microparticles for better polishing of the restorations. These ceramic fillers have a size of about 0.3-0.5 microns and occupy 20% of the total volume of BioHPP [7]. Because of their micro size, homogeneity is achieved in the macrostructure of the polymer. The high degree of polishability of the material results in a lack of plaque retention and colour stability over time.

BioHPP is as close as possible to the bone, because of its coefficient of elasticity (around 4 GPa). This is very important in implant treatment in cases when twisting forces may occur. The chewing pressure is transmitted as gently as possible, and the risk of fracture is reduced, as a result of the BioHPP modulus of elasticity close to that of the spongiose bone. [8].

BioHPP is particularly suitable for patients with allergies because the solubility of the polymer in water is very low <0.3 ìg / mm3. Extremely low weight is shown by the finished BioHPP restorations, which is considered as an advantage by the patients. Kistler et al., 2013 [9] conducted studies demonstrating high resistance to abrasion. BioHPP can be an alternative to chromium-cobalt dental alloys (Cr-Co) because it is lighter and does not cause corrosion [10].

BioHPP constructions can be constructed using both modern CAD / CAM technology and standard wax replacement technology [11].

In their studies, Schwitalla and Muller, 2013 [12] show that PEEK may be an alternative material for the production of dental implants. The combination of mechanical properties and high biocompatibility make PEEK / BioHPP a very attractive material for dental implantology.

Application of BioHPP for the production of removable partial dentures

BioHPP can be used for partial dentures frameworks. Due to fewer studies in this area, there is insufficient information for the effectiveness of clasps for removable partial dentures made of BioHPP. The strength of the framework is greatly increased by the ceramic nanoparticles addition, and this response to the requirements for a modulus of strength, optimal for permanent restorations. The modulus of elasticity increases to 4000 MPa and is comparable to that of the bone. Also, the bending strength is higher than 150MPa

Another use of BioHPP in Prosthetic Dentistry is for fabrication of removable dentures - obturators. The material is preferred because of its high biocompatibility and low relative density of 1.31 g/cm3. We can also mention other positive qualities - the crack resistance, the modulus of elasticity close to that of the bone and the easy polishability and processing [13].

Application of BioHPP for crown and bridge fabrication

Special laboratory composites are used in the design of crowns and bridge restorations based on BioHPP.

They cover the polymer and create a complete anatomical, functional and aesthetic final result. Full contour BioHPP restorations are also a possible alternative. BioHPP crowns are a great option for people with parafunctions (for example bruxism) because they do not abrade the antagonists and at the same time manage to withstand the high chewing pressure without fracturing. The polymer can be used for endocrowns fabrication [14].

Use of BioHPPfor individual implant abutments

Bearing in mind the high biological tolerance of PEEK, studies have been made for the possibility of making implants. A controlled clinical trial (RCT) conducted by Koutouzis [15] demonstrates that there is no significant difference in the bone resorption and the inflammation of soft tissues around PEEK and titanium superstructures. Furthermore, it has been shown that the attachment of the oral microflora to PEEK is similar in value to titanium and zirconium dioxide-based ceramic abutments. The modulus of elasticity of PEEK is very close to this of the bone, which reduces the stress and stimulates the bone modelling around the implant. These early studies have demonstrated the potential for PEEK use as an alternative to the titanium implants [16].

CONCLUSION

Nowadays investigations for new abilities to use PEEKs in Prosthodontics are conducted. These materials can be combined with metal alloys for alternative fixed restorations fabrication.

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