Peek (Polyether Ether Ketone) – A Review Article

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Abstract

This article is aimed to review the applications of Polyether Ether Ketone (PEEK) in dentistry. The evolving desire for functions and aesthetics, few drawbacks with existing materials and clinicians shifting their paradigms towards metal free restorations led space for the metal-free restorations in today's restorative practice. PEEK is a polymer based innovative material, that can be used in either fixed or removable prosthetics. This literature review discusses various applications and uses of PEEK.

***Keywords**: PEEK, Polyether ether ketone, aesthetics, biocompatibility, restoration*

Introduction

Advance in dentistry and development of technologies can be reached by improving materials. Biocompatibility, good oral hygiene, good aesthetics and characteristics close to dental structure are essential to modern materials used in advanced dentistry. It helps to rebuild the defects of the teeth and dentition and pleases demanding patients. Dental defects can be restored by using fixed or removable restorations. For better aesthetics and metal-free restorative treatment, we can prefer PEEK material which can be used in both fixed and removable prosthesis.

PEEK (-C6 H4 -OC6 H4 -O-C6 H4 -CO-)n is a semi-crystalline linear polycyclic aromatic polymer. Later PEEK became an important high-potential thermoplastic material for alternating metal implant components, in vertebral surgery as a material of the interbody fusion cage. Ma R, Tang T et. Al in2014 found that, With the introduction of carbon fibre reinforced PEEK (CF/PEEK), this new composite material was exploited for fracture fixation and femoral prosthesis in artificial hip joints[1].

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Physical Proprties of Peek

PEEK is rigid, radiolucent material with great thermal stability up to 335.8° C. It is non allergic and has low plaque affinity[2]. Density – 1300 kg/m3, Flexural modulus of PEEK is 140-170 MPa, thermal conductivity 0.29 W/Mk[3-6]. PEEK's mechanical properties do not change during sterilization process, using steam, gamma and ethylene oxide[3,5,6]. Young's (elastic) modulus of PEEK is 3-4 GPa[6,8]. Young's modulus and tensile properties are close to human bone, enamel and dentin[9]. Polyether ether ketone is resistant to hydrolysis, non-toxic and has one of the best biocompatibility[10,11]. PEEK shows stablephysical and chemical properties: stability at high temperatures (like sterilization processes), resistance to most substances apart from concentrated sulfuric acid and wear-resistance[1]. Lieberman et al.[12] in vitro research comparing PEEK, poly methyl methacrylate (PMMA) and composite resin showed that PEEK has the lowest solubility and water absorption values. As PEEK is quite new material in dentistry comparing to composite, ceramics or zirconia, it is important to find out and summarize its properties. The aim of this literature review is to understandPEEK polymer and its use in dentistry.

Discussion

PEEK is quite new material in prosthodontics. Comparing to the metals used in dentistry, PEEK is more aesthetic, stable, biocompatible, lighter and has reduced degree of discoloration[13,14]. This fulfils patient's aesthetic requirements. However, due to its grayish-brown

colour PEEK is not suitable for monolithic aesthetic restorations of anterior teeth[15]. High aesthetic material like composite can be used as a layering to obtaindesired aesthetics. Air abrasion with and without silica coating creates wettable surface, but etching with sulfuric acid makes rough and chemically processed surface[3,16]. Low energy of PEEK surface creates resistance to chemical processing. Uhrenbacher et al.[17] investigated the modification of the surface strength of PEEK crowns adhesively bonded to dentin abutments. The greatest values were found for the airborne-particle abrasion and sulfuric etched groups. The results of Hallmann et al. research show that abraded PEEK surface with 50 μm alumina particles followed by etching with piranha solution lead to the highest tensile bond strength when Heliobond was used as adhesive[14]. Various research confirms that resin composites can be used as a layering material for the PEEK frames. However, it is hazardous to use concentrated sulfuric acid in dental practice.

Mechanical properties of the PEEK resembles dentin and enamel. Thus its advantageous over metal and ceramic restorations. The fracture resistance of CAD- CAM milled PEEK fixed prosthesesis 2354N. It has higher resistance than lithium disilicate ceramic (950N), aluminium (851N) or zirconia (981-1331N)[18]. Mastication cyclically loads the teeth with a 400 N force. As PEEK has high fracture load resistance it is suitable for producing frames. High fracture resistance is also stated in Stawarczyk et al. publications. A mean fracture relative load was 1383 N of 3-unit PEEK frameworks without veneering[15].

Relatively weak mechanically in homogenic form. Tannous et al.[13] in vitro research showed that clasps that are made of PEEK material have low resistance forces than those made of cobalt – chrome metal. Scientists have searched for combinations with other materials, to improve PEEK's properties. Polyether Etherketonethat are modified containing 20% ceramic fillers known as BioHPP, is non allergic material and has high biocompatible. Possibility of corrections, excellent stability, great optimal polishable properties and aesthetic white shade of BioHPP help to produce high-quality prosthetic restorations[3]. BioHPP has a great potential as framework material. This is a good alternative to Cr-Co frames for the patients with high aesthetic requirements. But in clinical situations the results might be different. Individual abutments on implants can be milled of PEEK. They are usually used for temporary restorations. Randomized controlled clinical trial showed, that there is no statistically significant difference between PEEK and titanium abutments, causing bone resorption or inflammation. Moreover, the attachment of oral microorganisms to PEEK abutments is comparable to those made of titanium, zirconia and poly methyl methacrylate. Therefore, PEEK is a promising alternative to titanium abutments[3]. Comparing to titanium, the polymer could exhibit less stress shielding, but very limited inherent osteoconductive properties[3]. Thus PEEK has better Osseo integrative property. Nowadays, there are many combinations of PEEK with other materials such as fibres, carbon or ceramics. Due to its chemical structure and poor wetting capability of PEEK it is difficulty to fabricate its surface to increase its bond strength and bonding with composites. For better functioning, the surface of PEEK restorations has to be layered by resin composites or lithium disilicate. The best surface processing option is still not found. Moreover, composite as a coating material of the PEEK may degrade with time. So if the polymer frame remains stable, it is necessary to renew the coating material. These are extra expenses to the patient. Unfortunately, there was not enough clinical research made to prove PEEK's superiority over other materials. There is still not enough information stated about complications, biofilm formation on PEEK surface and its resistance to compression. Even so, PEEK is being used in manufacturing fixed restorations[17], dental implants, individual abutments, removable prostheses and their parts [3] and even maxillary obturator prostheses [19].

Conclusions

PEEK is an innovative material to use in prosthodontics. Due to its excellent physical, mechanical and chemical properties it is used in fabricating fixed and removable prostheses. As most of the studies have been carried out in vitro, more clinical research is essential for its better applications.

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Ethical Clearance – not required as it is a review article

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