



PEEK: A Futuristic Dental Material in Pediatric Dentistry

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Abstract

Polyetheretherketone (PEEK) material is a biocompatible polycyclic, aromatic, thermoplastic polymer having good mechanical and thermal properties. A retrospective literature search was conducted via PubMed, Web of Science, Scopus, Cochrane, and Google Scholar for the articles published in the past ten years using the MeSH terms 'polyetheretherketone', 'PEEK', 'dentistry', 'dental', 'pediatric dentistry'. The relevant articles were identified, screened and shortlisted. The screened articles were summarized. This review provides an insight into the properties and application of PEEK in pediatric dentistry. PEEK has a characteristic low elasticity modulus similar to that of bone that can enable its use as fixed and removable pediatric dental appliances in interceptive orthodontic and obturators. Additionally, PEEK can be used as a substitute for metals and other materials owing to its non-allergic properties and acceptable aesthetics.

Keywords: PEEK, pediatric dentistry, space maintainers

Introduction

Dentistry has been continuously evolving in terms of techniques and newer materials in order to achieve the ideal. The features of biocompatibility, low plaque affinity, aesthetics, and properties similar to dentine, enamel, and bone structure are imperative in newer materials to be incorporated in advanced dentistry. Polyetheretherketone (PEEK) is a semi-crystalline polycyclic aromatic polymer (Fig. 1). It is being considered as a high-performance thermoplastic polymer that can be used as an alternative to various prosthetic and restorative materials.[1] PEEK is a result of reaction between 4,4'-difluorobenzophenone and disodium salt

of hydroquinone in a polar solvent like diphenyl sulphone at a temperature of 300 °C, having a melting point of 335 °C.[2]

There are numerous newer materials being added in dentistry which makes it difficult to choose the most ideal one. Selection of treatment option for pediatric patients, restorative material specific to individual needs has to be evaluated. This ensures appropriate delivery of treatment within the limit of a particular material, considering each has its own advantages and disadvantages.

Advantages of PEEK:[3-5]

1. Biocompatible

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2. Low Plaque affinity
3. Mechanical properties that are similar to dentin and enamel. PEEK exhibits a Young's elastic modulus of 3-4 GPa, density of 1300 kg/m³ and the Flexural modulus ranges between 140-170 MPa.
4. Exhibits considerable wear and chemical resistance.
5. Good dimensional stability and thermal stability upto 335.8 °C which makes it suitable for use even after sterilization processes.
6. Provides radiolucent imaging and can therefore be used with magnetic resonance imaging (MRI), computerized tomography (CT), and X-RAY.
7. Remarkable aesthetics and polishing qualities.

Properties and uses of PEEK have been explored for various applications in clinical dentistry. This includes maxillofacial prosthesis as well as removable and fixed dental prosthesis. Dental implants made of PEEK have shown reduced stress shielding than titanium dental implants due to similarity in the mechanical properties of PEEK and bone. PEEK has also been explored for its use in Orthodontics and Endodontic procedures.

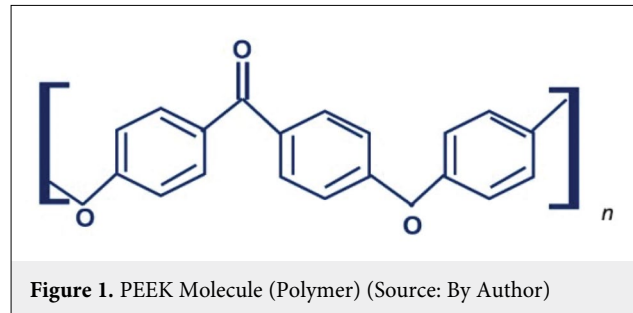
PEEK can be modified by various techniques such as mixing, filling, or carbon fiber reinforcement to obtain a more rigid material, making it more appropriate for dental procedures.

Although the use of PEEK material has not been widely explored and studied, some potential and promising uses of PEEK material based on preliminary researches have been summarized below:

Space maintainers and pediatric orthodontics

PEEK material can be used to overcome the disadvantages of conventional removable space-maintainers that show shrinkage and microcracks over the time. CAD-CAM assisted fabrication of space-maintainers using PEEK may replace the conventional self-cure and heat cure space maintainers to deliver efficient and aesthetic space maintainers.[6] A similar use has been studied in terms of fixed space maintainers in case of premature loss of primary molars with a good patient compliance and successful physical outcome.[7]

PEEK has also shown advantageous properties in the fabrication of esthetic metal-free orthodontic wires. PEEK orthodontic wires offer higher orthodontic resistance as compared to other polymers like polyethylene sulfone (PES) and polyvinyl difluoride (PVDF). Also, similar orthodontic forces can be obtained when compared to titanium-molybdenum (Ti-Mo) and nickel-titanium (Ni-Ti).[8]



Preformed pediatric crowns

Despite the successful use of various crowns in pediatric dentistry especially stainless-steel crowns, aesthetics still remains a concern. This has been overcome by Zirconia crowns, however, the need for extensive tooth preparation and high cost limits its use in dental practice. PEEK has also been considered to be a promising option to ceramic materials in crown restorations. Polydopamine (PDA) coating with plasma pretreatment for PEEK material has been seen to improve bonding characteristics of this material to primary teeth which makes it a potential restorative option for future.[9]

PEEK is originally white and non-gray rendering it a non-aesthetic material. However, veneering with resin composites can overcome this disadvantage. Conventional veneering method is inadequate to achieve optimal bonding between PEEK and composite material. Both direct and indirect composite material has been assessed for shear bond strength using different surface conditioning and curing techniques.[10] Studies have shown that treatment with sulfuric acid, alumina particle abrasion and plasma treatment can increase the bond strength.[11] On this ground, Khalesi et al[12] conducted a study to find an indirect composite with optimal mechanical properties and adequate bond strength, suitable for veneering PEEK. Amongst the three commercial composites, namely CRIOS (Coltene, Germany), High Impact Polymer Composite (HIPC; Bredent, Germany) and GRADIA (Indirect; GC, Japan), it was concluded that GRADIA exhibited the highest bond strength to PEEK whereas HIPC demonstrated the lowest.[12]

Commercialization and manufacture of colored PEEK material can be potentially used for improving and fabricating aesthetic pediatric appliances using CAD-CAM technology to create an advanced pediatric dentistry practice.

Obturator

Fabrication of maxillary obturators using PEEK can be considered in Cleft patients. High biocompatibility

and non-allergic nature can be of advantage for use in such patients. PEEK may provide a better-adjusted and lighter prosthesis to the patient.[13]

Pediatric endodontics

PEEK material may be used to manufacture tips for irrigation devices owing to its high chemical resistance. A study exploring the effect of various commonly used irrigants (sodium hypochlorite, chlorhexidine, and ethylene diamine tetra-acetate) on PEEK and polyamide material showed that PEEK retained its dimensional and physical characteristics and hence, could be used for manufacturing such devices for endodontic purpose.[14]

To the best of our knowledge, this is the first scientific literature focusing on applicability of PEEK in pediatric dentistry and its futuristic extension paving a way for advanced esthetic dentistry.

Conclusion

Dentistry has been on a continuous journey for the quest of better and advanced materials that can overcome the disadvantages of existing materials. PEEK is one such latest invention that has shown remarkable properties with added advantages over the conventional materials. The existing literature and research pave a way for future studies to validate the use and applicability of PEEK in various procedures of pediatric dental practice that can provide an improvised and efficient treatment option.

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