Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Spl Issue [2] 2022 : 583-587

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Peek Its Utilization and Evolution in Prosthodontics

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ABSTRACT
Finding the best replacement for missing dentofacial components has been the subject of ongoing research. In the past, materials like wood, shell, ivory, rubber, metal, and plastic have all been used. Dentists now have access to more promising materials because of advancements in dental materials, but none of them is perfect. Oral conditions require a material with good mechanical, biological, and cosmetic qualities. Currently, Polyether ether ketone (PEEK) is one of the safest, scientifically certified materials that can be used to replace missing orofacial tissues. Peek has many uses in the field of dentistry, including implants, removable and FPD, and orthodontic wires. The benefits and drawbacks of employing polyether ether ketone are covered in this study.
Keywords: *Peek implants, Removable Prosthesis, Fixed Prosthesis, Peek in Orthodontic and Pediatric Dentistry.*

Received 10.08.2022 Revised 21.09.2022 Accepted 27.10.2022

INTRODUCTION

Polyether ether ketone is a thermoplastic that is semi-crystalline, polycyclic, and aromatic, linearly structured polymer. This substance, which is initially tan in colour, results from the interaction of aryl rings and ketone and ether functional groups [1]. Polyether a high-performance engineering thermoplastic is ketone (PEEK). Based on ketone and semi crystalline. Due to its superior chemical resistance, low flammability, high thermal dimensional stability, and excellent mechanical qualities across a wide temperature range, PEK is frequently utilized for demanding applications in a number of applications [2-3].

Recent dental treatments are progressively using metal-free restorations considering aesthetic concerns, Polyether ether ketone has many potentials uses in dentistry is the metal free restorations that. PEEK is advancing reputation in prosthodontics oral implantology and due to its excellent properties. Titanium materials have certain medical issues, include metal sensitivities and allergy [4]. Periimplantitis and impurities, a high elasticity modulus, and a metallic color that is inappropriate for aesthetic applications. These problems can be solved by PEEK-based materials and PEEK can be a viable substitute to Titanium [5-6]. Due to its strong mechanical and aesthetic qualities, PEEK can also be employed as a framework for both fixed and removable dental prosthetics. PEEK has several applications, including

1. Spinal &other orthopedics surgeries
2. Dental ,maxillofacial ,cranial implant

The areas of peek use in dentistry are

1. Fixed prosthesis
2. Removable dentures
3. Maxillofacial prosthesis
4. Endocrowns
5. Wires for orthodontics
6. Implant: bar abutments, healing caps, temporary abutment [7-8].

THE CHARACTERSTIC OF PEEK MATERIAL

PEEK, A wax waste management technique, pressure- and heat-assisted casting, and CAD-CAM technology are all used to create this., offers a number of advantageous characteristics, including:

1. Inability to hydrolyse.
2. Excellent Mechanical Characteristics
3. Tolerant to extreme temperatures [9-10]

There was in the toxic form, there is no proof of apoptosis, genotoxicity, mutagenicity, or immunogenicity [11]. When material and components PEEK were tested. The resistance to deterioration of PEEK, a material that is biologically inert, has been seen during various sterilising processes. Since PEEK has a melting point more than 280°C, heat sterilization techniques can be used to process it. It has a high level of chemical wear resistance. PEEK can be altered in combination with other materials (table 1). The most significant characteristic of this material is its low elasticity modulus, which is comparable to the elasticity modulus of bone [12]. The resistance to deterioration of PEEK, a material that is biologically inert, has been seen during various sterilising processes. Since PEEK has a melting point more than 280 °C, heat sterilisation techniques can be used to process it. It has a high level of chemical wear resistance [13]. PEEK can be altered in combination with other materials. The most significant characteristic of this material is its low. When a higher elasticity modulus is desired, carbon fibres can be added to PEEK to raise the material's elasticity modulus to high levels. The material has a minimal density (1.32g/cm^3) and is very light [14-15]. PEEK's elastic modulus is remarkably similar to that of human bone. Exhibiting uniform stress transfer to neighbouring tissues. Due to its radiographic radiolucency and applicability for medical purposes it shows minimal density (1.32 g/cm^3) [16].

Table 1. Elasticity modulus

	Elasticity modulus
Cortical bone	13.7 GPa
Spongeous bone (Type 3)	1.37 GPa
Dentin	14.7 GPa
Titanium Implant and Abutment	110 GPa
Chrome-Cobalt Alloy	218 GPa
Feldspathic Porcelain	82.8 GPa
Zirconium	200 GPa
PEEK	3-4 GPa
CFR-PEEK	19-150 GPa

PEEK APPLICATIONS IN DENTISTRY

Polyether ether ketone thrived as due to its ideal properties, a biomaterial in medicine, and immediately explored its applications in dentistry. Different surface adjustments have permitted PEEK to bond with various luting agents. It is a suitable dental restorative material because, its Tensile properties comparable to those of bone, enamel, and dentin. PEEK is effectively used in dentistry as implants, framework for removable and fixed prosthesis due to its biocompatibility and the favourable [17].

AREA USES FOR PEEK MATERIAL

PEEK has been widely utilised in the chemical, electronics, and chemical sectors for a long time because of its exceptional mechanical and electrical qualities, including resistance to high temperatures and hydrolysis. Other positive characteristics including its great resistance to chemical wear, low radiation penetration, and ability to be changed with many different materials (including glass and carbon fibres) promote its utility as a metal alloy alternative in industrial settings [18-20].

PEEK IN IMPLANTS

One of the most well-known marches of achievement and fulfilment in tooth replacement in contemporary dentistry is implant treatment. Due to its low elasticity modulus and ease of modification and reinforcement with carbon and glass fibres, PEEK is a durable alloy that can be utilized for implants [21]. PEEK has very low water solubility, and in comparison to many other materials, it receives relatively little reaction from users, especially those who are allergic. PEEK is a suitable alternative to metallic implants since it does not deteriorate when exposed to radiation. Titanium material does not exhibit

shock absorption while chewing because of its high elastic modulus [22-23]. The PEEK material's elasticity modulus is virtually identical to bone's, inducing stresses that would otherwise be generated on the bone through the absorption of forces. The benefit of bone protection is provided by the shock-absorbing material [24].There is no PEEK and conventional implant materials like titanium and zirconium can be differentiated from one another, according to studies that compared them with PEEK. PEEK material, unlike titanium, has very little osteoconductive characteristics, according to earlier investigations [25]. Therefore, extensive study has been done to improve the bioactivity of PEEK implants. The analysis of surface mechanical exfoliation is one of the main ones. Implant abutments can be made from a variety of materials, including glass, zirconia, titanium, gold, and alumina. High-strength polymer materials, such as PEEK, are also advised as abutments in several implant-supported restorations. Compared to zirconia and titanium abutments, the peek abutment exhibits a very low level of bacterial biofilms. PEEK is a permanent immediate abutment and framework material that can be utilised [26].

PEEK ABUTMENTS

Important subjects include implant-supported interventions and implant osseointegration. The abutment material must satisfy the demands of mechanics, biology, and aesthetics. Various materials, such as titanium, gold, zirconium, and ceramics, are used to make abutments. A titanium basis can also be used to create PEEK, a ductile material [27]. The study reveals that PEEK abutments deformed but did not break when compared to zirconium abutments, whereas there was no breaking observed in the zirconium abutments. PEEK material exhibits deformation rather than fracture because of its semi-crystalline structure, which lessens fragility. Because PEEK abutments are simple to replace and broken screws aren't as difficult to remove, problems that can occur in higher constructions can be simply fixed.

PEEK MATERIAL'S APPLICATION IN FIXED PARTIAL DENTURE

The application of polyether ether ketone material in implant-supported prosthetics for fixed prostheses devices, crown materials make up the upper structure. Ceramics with metal supports have utilised in dentistry for a long time, and the results have demonstrated their effectiveness. However, there are certain downsides to metal alloys, including the risk of allergies and rusting. Lack of light permeability is another drawback of metal alloy. PEEK should be veneered with composites since it is opaque and serves as a framework for fixed prostheses. PEEK's natural colour in unfilled material is grey, but it can be changed by adding the right colours. Since PEEK is chemically inert. To achieve a satisfactory bond strength with veneering materials, numerous procedures have been tried [28]. Sandblasting, the fully protect method, surface etching with sulfuric acid, and voracious are other surface treatments. PEEK material has greater potential for use as crown material because it can be repaired much more simply than ceramics, does not deteriorate inside the mouth, and processing shows no signs of doing so either. In addition, PEEK can compete with metallic alloys despite having low elasticity modulus and hardness because to its strong wear resistance. During the permanent loading phase of the all-on-four treatment regimen, implants supported fixed prosthesis can be produced using PEEK framework. Zoidis showed PMMA veneered PEEK as a good accretive to conventional ceramic and PFM prosthesis.

PEEK WITH REMOVABLE PROSTHESIS

Removable prosthesis indications are influenced by the material used, the intraoral examination, and the patient's expectations. The removable mucosa or teeth act as supports for dentures. PEEK is used in removable partial prosthesis in place of titanium bracing and screws. Lower retentive strength has been observed in PEEK than partial prosthesis made of chrome-cobalt [29]. Clasps and dentures can be made from PEEK using CAD CAM because to its light weight and excellent biologic, cosmetic, and mechanical properties. Detachable obturators can be created with PEEK material. PEEK material improves patient comfort in partial denture frameworks because PEEK is strong and lightweight [30]. Patient customization is also possible with digital design based on individual physiology due to properties like lack of metal taste, no heat, and X-ray compatibility, non-allergenicity, and electrical conductivity. PEEK structures provide shock absorption, have a very good resistance against deterioration and wear during mastication, even though metals are very strong, yet flexibility and patient comfort are also very important [31]. In detachable partial prosthesis with distal extension. It is believed that dental prosthesis with PEEK substructures support tooth health. The tooth's stress and torque force are both decreased. due materials flexibility. Therefore, lighter prostheses are now possible, which improves patient ease and satisfaction.

PEEK has been found to have more stable colour changes when compared with various resin materials for prosthetics [32].The effects of polishing techniques used in the clinic and laboratory have been examined

in terms of surface roughness and free surface energy on polyether ether ketone, PMMA, and a composite resin. PEEK is more resilient and has reduced free surface energy and surface roughness [33].

PEEK in Orthodontics and Paediatric Dentistry

Uses of polyether ether ketone in both orthodontia and pediatric dentistry. It is used as a space maintainer and can be created digitally. The purpose of this is to raise the standard of care. Moreover, the orthodontic tool PEEK has a lot of potential. An alternative to metallic orthodontic arc wires is PEEK [34]. Because of PEEK's great bending strength, creep resistance, similar orthodontic force to Ni-T wire, and minimal water absorption, Ni-Ti wires can easily be substituted with PEEK wires. PEEK is seen as a nonmetal and cosmetic arc wire.

Research into the creation of PEEK Materials

PEEK material is relatively easy to modify and may be altered using a range of materials. It has been shown that resistance to wear acquired mechanical characteristics after being modified with glass and carbon fibres. As anoutcome of PEEK modification at various rates of carbon fibre, titanium dioxide, barium sulphate, and glass fibre PEEK is observed to have superior technology, hardness, great durability, and wear resistance [35]. As PEEK lacks adequate lucidity, some scientists claim that veneer covering is the best option.

CONCLUSION

Superior physical, mechanical, cosmetic and biocompatibility characteristics makes PEEK material suitable for various dental applications, e.g., fixed and detachable prostheses, implants, etc. The major challenge is to increase the bioactivity of using PEEK as an implant material without changing its characteristics. There are still more experiments needs to be done, PEEK bioactivity must be tested using different materials and techniques. Potential PEEK applications are substitute for the nasal, maxillary, and implants in the skull, osteosynthesis plates, and mandibular reconstructions and dental implants. Quick prototyping and CAD CAM has made it possible to generate customised products (prosthesis).Carbon fibre reinforcement has enhanced the PEEK's mechanical characteristics making CFR-PEEK is a more desirable material than metallic ones. PEEK polymers outperform all other biomaterials now in use and have long been utilised in clinical investigations because they are stronger, inert, and more biocompatible by nature. Neither the particles nor the bulk material causes an unwanted biological response.

REFERENCES

1. Tekin S, Cangül S, Adıgüzel Ö, Değer Y. (2018). Areas for use of PEEK material in dentistry. IntDent Res; 8(2):84-92.
2. Ortega-Martínez J, Farré-Lladós M, Cano-BatallaJ,Cabratosa-Termes J. (2017). Polyetheretherketone (PEEK) as a medical and dental material. A literature reviews. Arch Med Res. 5(5):01-16
3. Rahmitasari F, Ishida Y, Kurahashi K, Matsuda T, Watanabe M, Ichikawa T. (2017). PEEK with Reinforced Materials and Modifications for Dental Implant Applications. Dent J (Basel). 5(4):35.
4. Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. (2016). Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. J Prosthodon Res. 60:12-19
5. Tekin S, Adıgüzel Ö, Cangül S. (2018). An evaluation using micro-CT data of the stress formed in the crown and periodontal tissues from the use of PEEK post and PEEK crown: A 3D finite element analysis study. Int Dent Res. ;8(3):144-50.
6. WenzLM, Merritt K, Brown SA. (1990). In vitro biocompatibility of polyetheretherketone and polysulfone composites. J Biomed Mater Res. 24: 207–215.
7. Kurz SM, Devine JN. (2007). Peek Biomaterials in Trauma, Orthopedic and Spinal İmplants. Biomaterials. ;28(2):4845-4869
8. Rodriguez F, Cohen C, Ober CK, & Archer L. (2014). Principles of Polymer Systems 6th Edition. New York: Taylor& Francis US.
9. Siewert B, Parra M. (2013). A new group of material in dentistry. PEEK as a framework material for 12-piece implant-supported bridges. ZahnarztlImplantol. 29:148-159.
10. Han X, Yang D, Yang C, Spintzyk S, Scheideler L, Geis-Gerstorfer J. (2019). Carbon fiber reinforced PEEK composites based on 3D-printing technology for orthopedic and dental applications. J. Clin. Med. 8:240.
11. Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. (2016). Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. J Prosthodon Res. 60:12-19.1
12. Rahmitasari F, Ishida Y, Kurahashi K, Matsuda T, Watanabe M, Ichikawa T. PEEK with Reinforced Materials and Modifications for Dental Implant Applications. Dent J. 2017;5(35):1–8
13. Eschbach L. (Nonresorbable polymers in bone surgery. Injury. 2000;31(4):22-27.
14. Bassi MA, Bedini R, Pecci R, Ioppolo P, Laritano D, &Carinci F. Mechanical Properties of Abutments: Resin-Bonded Glass FiberReinforced Versus Titanium. The International journal of prosthodontics. 2016;29(1):77-79.
15. Stephan A. A wealth of possible applications for high performance polymers. Quintessenz Zahntech. 2013;(3):2-10.

16. Schwitalla A, & Müller WD. (2013). PEEK dental implants: a review of the literature. Journal of Oral Implantology ;39(6):743-749.
17. Koch F, Weng D, Kra¨mer S, Biesterfeld S, Jahn- Eimermacher A, Wagner W. (2010). Osseointegration of one-piece zirconia implants compared with a titanium implant of identical design: a histomorphometric study in the dog. Clin Oral Implants Res. 21:350–6.
18. Wu X, Liu X, Wei J, Ma J, Deng F, Wei S. (2012). Nano-TiO2/PEEK bioactive composite as a bone substitute material: in vitro and in vivo studies. Int J Nanomed. 7:1215–25.
19. Zok F, Miserez A. (2007). Property maps for abrasion resistance of materials. Acta Mater. 55: 6365–71.2
20. Karunagaran S, Paprocki GJ, Wicks R, & Markose S. (2013). A review of implant abutments-abutment classification to aid prosthetic selection.The Journal of the Tennessee Dental Association. 93(2):18-23.
21. Schwitalla AD, Bötel F, Zimmermann T, Sütel M, Müller WD. (2017). The impact of argon/ oxygen low-pressure plasma on shear bond strength between a veneering composite and different PEEK materials. Dent Mater. ;33(9):990-94,
22. Keul C, Liebermann A, Schmidlin PR, Roos M, Sener B, Stawarczyk B. (2014). Influence of PEEK surface modification on surface properties and bond strength to veneering resin composites.J Adhes Dent. 16:383-392.
23. 23.Zok F, Miserez A. (2007). Property maps for abrasion resistance of materials. Acta Mater. 55: 6365–71.
24. Zoidis P. (2016). The all-on-4 modified polyether ether ketone treatment approach: A clinical report. J Prosthet Dent. 119(4):516–21.
25. Tannous F, Steiner M, Shahin R, Kern M. (2012). Retentive forces and fatigue resistance of thermoplastic resin clasps. Dental Mater. 28:273–281.
26. Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. (2016). Applications of polyether ether ketone (PEEK) in oral implantology and prosthodontics. J Prosthodon Res. 60:12-19
27. Whitty T. PEEK- A New Material for CADCAM Dentistry. 2014.
28. Heimer S, Schmidlin PR, Roos M, Stawarczyk B.(2017). Surface properties of polyether ether ketone after different laboratory and chair side polishing protocols. J Prosthet Dent. 117(3):419–425.
29. Ierardo G, Luzzi V, Lesti M, Vozza I, Brugnoletti O, Polimeni A, et al. (2017). Peek polymer in orthodontics: A pilot study on children. J ClinExp Dent. 9(10):e1271–5.
30. Maekawa M, Kanno Z, Wada T, Hongo T, Doi H, Hanawa T, et al. (2015). Mechanical properties of orthodontic wires made of super engineering plastic. Dent Mater J. 34(1):114– 9.
31. Shirakawa N, Iwata T, Miyake S, Otuka T, Koizumi S, Kawata T. (2018). Mechanical properties of orthodontic wires covered with a polyether ether ketone tube. Angle Orthod. 88(4):442–9.
32. Tada Y, Hayakawa T, Nakamura Y. (2017). Load-deflection and friction properties of PEEK wires as alternative orthodontic wires. Materials (Basel). 10(8):1–12.
33. Wiesli MG, &Özcan M. (2015). High-performance polymers and their potential application as medical and oral implant materials: a review. Implant dentistry. 24(4):448-457.
34. Grupp TM, Giurea A, Miehlke. (2013). Biotribology of a new bearing material combination in a rotating hinge knee articulation.ActaBiomater. 9:7054–7063.
35. Costa-Palau S, Torrents-Nicolas J, Brufau-de Barbera M, Cabratosa-Termes J. (2014). Use of polyether ether ketone in the fabrication of a maxillary obturator prosthesis: a clinical report. J Prosthet Dent. 112:680–2.

CITATION OF THIS ARTICLE

K Solanki, R Sanan, A Nagpal, O Shetty, B Yadav, B Raina. Peek Its Utilization and Evolution in Prosthodontics. Bull. Env.Pharmacol. Life Sci., Spl Issue [2]: 2022: 583-587