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Commentary

The Place of PEEK in Dentistry and Implantology

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Received: December 26, 2017; **Published:** February 17, 2018

Introduction

PEEK Medical Polyether ether ketone is a high performance polymer. The materials in this group combine excellent mechanical properties with the highest biological compatibility. PEEK is also used in aircraft construction for heavy parts and for medical applications. It has experienced an evolution in the dental field, especially for the manufacture of dental prosthesis frameworks. The elasticity of the material, which is similar to that of bone tissue, makes it a material similar to nature since it can compensate for bone torsion, especially in case of major implantation work. It replaced titanium because of its properties and qualities. This work aims to demystify this material by demonstrating its advantages and limitations as well as its place in current dentistry.

Definition

PEEK appears in the medical literature as a non-metallic alternative to Titanium. It has mechanical properties close to those of the bone that allow it to be perfectly integrated on a biological level. Nevertheless, PEEK biointeresis is the main limitation of this material. Surface treatment or hybridization (PEEK-ceramics and CFR-PEEK) overcome this problem by giving it a bioactive character [1].

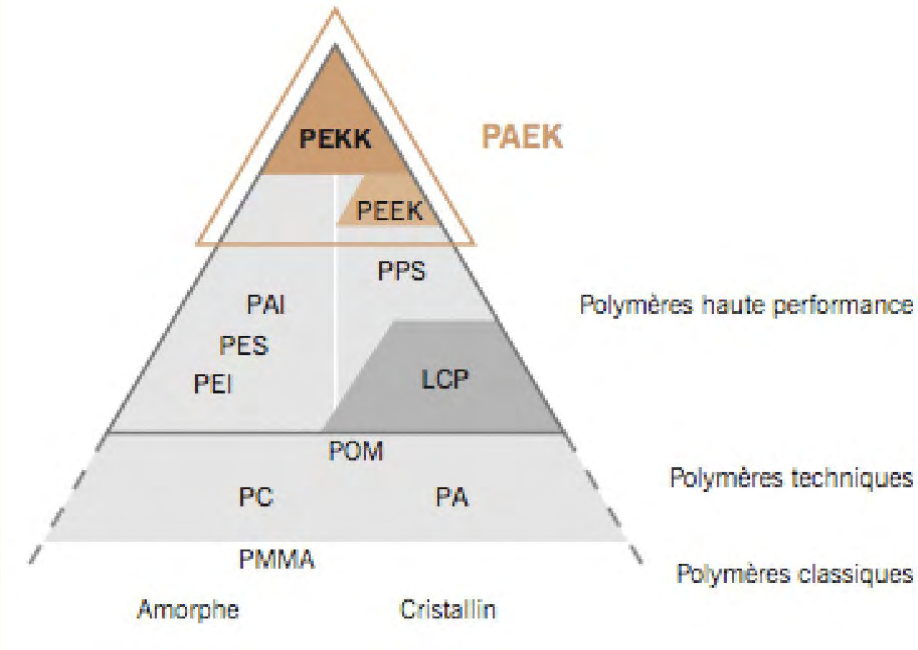

Figure 1: *The high performance polymer is at the top of the quality pyramid [2].*

Polyether Ether Ketone admits for acronym PEEK, or Oxy-1,4-Phenylene-Oxy-1,4-Phenyl-Carbonyl-1,4-Phenylene. Polyether ether ketone or Oxy-1,4-Phenylene-Oxy-1,4-Phenomenon-Carbonyl-1,4-Phenylene is a ketone belonging to the family of Polyaryletherketones (PAEK).

PAEKs also include Polyetherketone (PEK), Polyetherketoneketone (PEKK), Polyetheretherketoneketone (PEEKK), and Polyetherketoneetherketone-Ketone (PEKEKK). This family of semi-crystalline thermoplastic materials includes composite materials consisting of a series of very stable phenyl compounds and aromatic rings joined by an oxygen atom: the Ether group, expressed as ROR and the ketone group, R-CO-R, R representing the carbon chain. PEEK, synthetic polymer, appears under the flat semi-developed formula (-C6H4-O-C6H4-O-C6H4-CO-)n, where n is the repetition number of the motif [2].

High performance polymers (PHP) are high quality plastics: they have better thermal and chemical stability as well as better mechanical properties than commodity plastics. But generally they are manufactured in smaller quantities and cost more. The family of PHP who has entered the dental sector is called polyaryletherketones (PAEK). This family has several members with various chemical structures. In the dental sector, many of us have been involuntarily acquainted with the member of this family called PEEK (polyetheretherketone), because it is used in healing caps, temporary abutments and scan equipment. But PEAKs have attracted so much attention lately because of the possibility of using them as an alternative to metal in a wider range of indications such as Removable Dentures and Implanted Prostheses [3].

PEEK in prosthesis

The use of Pekkton® ivory as framework material resulted in a frank reduction of the mechanical stresses on the framework while the stresses on the coating increased. The changes in mechanical behavior of the bridge had no influence on the loading of the surrounding hard and soft tissuesT.

A 60-year-old female patient who has chosen Pekkton ivory restorations for their shock absorbency, we are in the presence of a complete antagonist bridge (Figure 2).

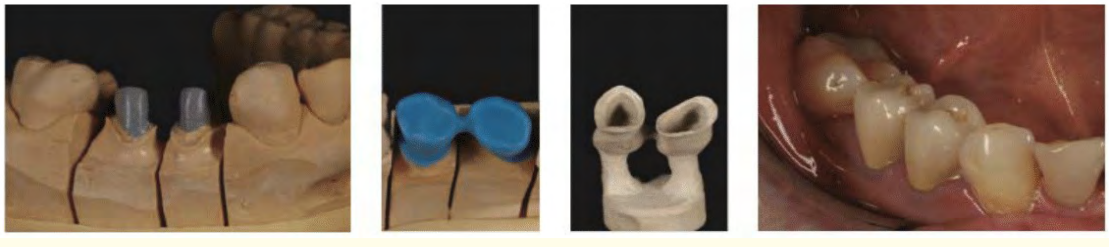

Figure 2: *The laboratory stages until the mouthing [3].*

Thickness of frame material

Pekkton Ivory	Crown anterior tooth	Posterior tooth	Anterior tooth bridge	Posterior tooth
Modelage type	Based on the shape of the tooth	Based on cusps	Based on the shape of the tooth	Based on cusps
minimum thickness of the circular wall	> 0,6 mm	> 0,6 mm	> 0,6 mm	> 0,6 mm
minimal thickness of the occlusal wall	> 0,8 mm	> 0,8 mm	> 0,8 mm	> 0,8 mm
section of the connecting element	-	-	> 12 mm^2	> 14 mm^2

Table 1: *Thickness of the frame material according to the situation [3].*

Sealing

Sealing mode	Classical CVI	Self adhesive	Adhesive
Stump	Stump length > 4 mm Angle of préparation: 4''- 8''	Stump length > 4 mm Angle of préparation: 4''-8''	Stump length < 4 mm Angle of préparation: > 8 mm

Table 2: *Parameter of the moigon depending on the nature of the product [3].*

PEEK in Implantology

Just like the bone that incorporates an organic phase and a mineral phase, PEEK is a composite material (crystalline phases included in a rubbery amorphous matrix). Its modulus of elasticity (3 to 4 GPa, against 110 GPa for Titanium) is closely related to that of the cortical bone which is 20 GPa, and more particularly to that of the trabecular bone estimated at 1 GPa. Its low modulus of elasticity gives it a moderate rigidity, favorable to the bone because it does not exert any notable stress on the latter [15,18]. This parameter allows a good integration of the PEEK implant by the bone, due to a better distribution of the stresses exerted during the solicitation of the implant. Thus the PEEK abstains from the phenomenon of stress shielding reproached to Titanium and Zirconia. The clinical experience of the material is more of its use in other medical fields than in dentistry, its use being widespread and confirmed with a significant clinical experience in medical branches such as orthopedics and trauma. Studies indicate that this polymer has been used for nearly 30 years in orthopedic and traumatological surgery, and attest to a very successful clinical follow-up and level of success [4-10,22].

However, its application to the dental field is relatively recent; as a result, there are only a small number of studies on the subject and a relatively small clinical follow-up [5,9-22]. Nevertheless, its proven value in other areas, medical and non-medical, has left us predicting that PEEK could prove to be a significant alternative to Titanium in dental implantology as well. The clinical decline of the material is more related to its use in other medical fields than in dentistry, its use being widespread and confirmed with a significant decline in medical branches such as orthopedics and traumatology. Seven Some studies indicate that this polymer has been used for nearly 30 years in orthopedic and traumatological surgery, and attest of a clinical experience and a very satisfactory level of success [5,6-10,22]. However, its application to the dental field is relatively recent; as a result there is only a small number of studies on the subject and a relatively low clinical follow-up [5,9-22]. Nevertheless, its proven value in other areas, medical and non-medical, has left us predicting that PEEK could be a significant alternative to Titanium in dental implantology as well.

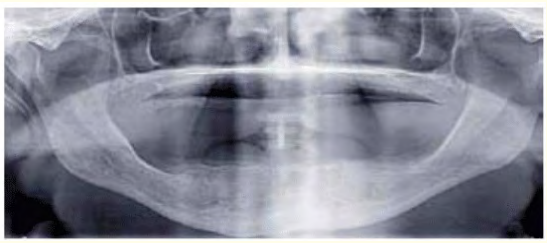

Figure 3: *Total toothless patient: X-ray.*

Figure 4: *Implementation project.*

Figure 5: *Implant retro alveolar.*

Conclusion

High performance polymers PEEK and PEKK have interesting potential in dentistry for the replacement of metal in removable infrastructure and implant Suprastructure. Their properties in terms of rigidity are promising for creation infrastructure that could add additional property of absorption of shocks. This can have advantages for the comfort of patients, improving the parafunction and to limit the damage.

Increasingly used by prosthetic laboratories, the use of Peek in implantology remains rare. Nevertheless, this material has few advantages that still little discussed so far addressed to date in implantology. Indeed, the modulus of elasticity of the Peek is four times lower than that of titanium's one. A stress generated on the bone by a titanium implant, following its activation, will be all the more traumatic. Placing the PEEK implant requires an impaction technique that the practitioner must master.

Bibliography

1. "Le matériau Peek en implantologie une alternative au titane". Stratégie prothétique 15.5 (2015).
2. Cendres métaux pekketon ivory polymère a hautes pour restaurations définitives sur implants.
3. Mode d'emploi Pekkton® ivory: Utilisation, préparation et scellement.
4. BioHPP. "La nouvelle gamme de matériaux en prothèse". SYSTEM.
5. Nandi SK and Biswas S. "Chapter 6-In Vivo Characterization of Biomaterials". *Characterization of Biomaterials* (2013): 255-297.
6. Knebel M. "Titanium in difficulties". Kunststoffe international (2010).
7. Morrison C., *et al*. "In vitro biocompatibility testing of polymers for orthopaedic implants using cultured fibroblasts and osteoblasts". *Biomaterials* 16.13 (1995): 987-992.
8. Cho DY., *et al*. "Preliminary experience using a polyetheretherketone (PEEK) cage in the treatment of cervical disc disease". *Neurosurgery* 51.6 (2002): 1343-1350.
9. Horák Z., *et al*. "Polyetheretherketone (PEEK). Part I: prospects for use in orthopaedics and traumatology". *Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca* 77.6 (2010): 463-469.
10. Schwitalla A and Müller W-D. "PEEK Dental Implants: A Review of the Literature". *Journal of Oral Implantology* 39.6 (2013): 743-749.
11. Ma R and Tang T. "Current Strategies to Improve the Bioactivity of PEEK". *International Journal of Molecular Sciences* 15.4 (2014): 5426-5445.
12. Schwitalla AD., *et al*. "Finite element analysis of the biomechanical effects of PEEK dental implants on the peri-implant bone". *Journal of Biomechanics* 48.1 (2015): 1-7.
13. Kurtz SM. "An Overview of PEEK Biomaterials. PEEK Biomaterials Handbook". Elsevier (2012): 1-7.
14. Zhou H., *et al*. "A fast route to modify biopolymer surface: A study on polyetheretherketone (PEEK)". *Materials Letters* 125 (2014): 96-98.
15. Lee W-T., *et al*. "Stress shielding and fatigue limits of poly-etherether-ketone dental implants". *Journal of Biomedical Materials Research Part B: Applied Biomaterials* 100.4 (2012): 1044-1052.

16. Wu GM., *et al*. "Investigation of hydroxyapatite coated polyether ether ketone composites by gas plasma sprays". *Surface and Coatings Technology* 203.17-18 (2009): 2755-2758.

17. Zhao M., *et al*. "Quantitative proteomic analysis of human osteoblastlike MG-63 cells in response to bioinert implant material titanium and polyetheretherketone". *Journal of Proteomics* 75.12 (2012): 3560-3573.

18. Briem D., *et al*. "Response of primary fibroblasts and osteoblasts to plasma treated polyetheretherke- tone (PEEK) surfaces". *Journal of Materials Science: Materials in Medicine* 16.7 (2005): 671-677.

19. Zhao Y., *et al*. "Cytocompatibility, osseointegration, and bioactivity of three-dimensional porous and nanostructured network on polyetheretherketone". *Biomaterials* 34.37 (2013): 9264-9277.

20. Xu A., *et al*. "Enhancement of osteogenesis on micro/na- no-topographical carbon fiber-reinforced polyetheretherketone–nanohydroxyapatite biocomposite". *Materials Science and Engineering C* 48 (2015): 592-598.

21. Cougoulic J-P., *et al*. "Un nouveau matériau « metal-free » en Im- plantologie : le Biopik". *Implantologie* (2010).

22. Li CS., *et al*. "The Use of Carbon-Fiber-Reinforced (CFR) PEEK Material in Orthopedic Implants: A Systematic Review". *Clinical Medicine Insight: Arthritis and Musculoskeletal Disorders* 8 (2015): 33-45.

Volume 17 Issue 3 March 2018