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## **Role of PEEK in RPD: A systematic review**

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**Abstract**--Aim This systematic review aims to analyse and appraise the literature concerning PEEK dental prostheses critically. Methodology The following focused question was constructed 'Are dental prostheses made of PEEK inferior to those made of other materials in terms of clinical- and patient-reported outcomes?'. The CONSORT (Consolidated Standards of Reporting Trials) tool was used for the quality assessment of the randomised clinical trials. Results A total of 12 studies were included in this review. Two case studies received an overall grade of medium and the overall quality of six studies was graded as 'low'. All three observational studies and the only randomised controlled trial received scores of 'medium'.

Conclusion PEEK-based dental prostheses may provide a viable and more esthetic alternative to conventional prosthodontic appliances. However, within the limitations of this study is the evidence to ascertain the long-term viability of PEEK-based dental prostheses. Future studies should focus on conducting large-scale, multicenter trials to compare the survival rate of PEEK prostheses to that of conventionally available prosthodontic appliances.

**Keywords**---polyetheretherketone; dental prostheses; prosthodontics.

## Introduction

Advances in field of dental sciences and innovations in technologies has led to introduction of improved materials. Biocompatibility, low affinity towards plaque and debris, improved esthetics and properties close to teeth are some of the properties to modern materials used in dental sciences. These materials help to restore the defects of the teeth and associated structure.<sup>1</sup> In spite of countless inventions of this topic, still search is going on to find out the material which will be upto the standard requirements.<sup>2</sup> The practice to find most improved material is ongoing and in current literature directed to meet the biocompatible material and aesthetic demands, Polyetheretherketone (PEEK) bio material has been established that can assist the mechanical and aesthetic properties in field of dental sciences.<sup>3</sup> PEEK is a tooth coloured synthetic material that has been used for many years in the field of orthopaedics.<sup>4-6</sup> As PEEK is new material in dental field compared to other restorative materials, it is important to explore its properties. PEEK (-C<sub>6</sub>H<sub>4</sub>-OC<sub>6</sub>H<sub>4</sub>-O-C<sub>6</sub>H<sub>4</sub>-CO-) *n*, is a linear polycyclic semi-crystalline polymer. In 1978 PEEK was developed by English scientists and after that PEEK was commercialized for various applications in other fields. During late 1990s, PEEK was considered as an extraordinary enacted thermoplastic substance for substituting metal implant. After introducing carbon fibre reinforced PEEK, this material was exploited for fixation of fracture and femoral prosthesis in hip joints replacement.<sup>7</sup> In 1992, PEEK material was utilized in dental arena, in the form of aesthetic abutments and as implants<sup>8</sup> and in 2013 a study reports that PEEK might be exploited as a better option for FDP.<sup>9</sup> Titanium and its alloys and Zirconium are predominant in the field of implant materials in today's dental practice. Studies have already proven that these materials are biocompatible, but even these have some short comes, one of them being the elastic modulus. The elastic modulus of titanium and zirconia are 110 and 210 GPa respectively which is 5-14 times greater than that of compact bone having 15 GPa.<sup>10,11</sup> Due to the gradient difference in the elastic modulus of a titanium implant to its surrounding bone, it may cause stress in the implant-bone interface during load transfer resulting in peri-implant bone loss.<sup>11</sup> This phenomenon is referred to as stress shielding, and it may be one of the important causes of long term failure of dental implants. Titanium implants are also known to cause image distortions in MRI scans.<sup>12</sup> Few studies also claimed that titanium is prone to hypersensitivity reactions.<sup>13</sup> Titanium can cause aesthetic problems due to its lack of light transmission.<sup>14</sup> This can provoke a dark shimmer of the peri-implant soft tissue in cases of thin biotype mucosa and mucosa recession around the implant.<sup>15</sup> The existing materials despite having superior qualities

have certain drawbacks like attrition of the natural teeth and bulkiness which may lead to a compromise in the retention of the prosthesis as well as patient satisfaction. The dental profession always thrives for better materials which can fulfil the pitfalls of the existing materials. PEEK is the latest inventory of dentistry and is claimed to have better properties in parallel with existing materials.

### **Aim of The Present Study**

This systematic review aims to analyse and appraise the literature concerning PEEK dental prostheses critically especially in case of RPDs.

### **Methodology**

Using the Participant, Intervention, Control and Outcomes (PICO) principle provided in the Preferred Reported Items for Systematic Reviews and Meta-analyses (PRISMA) statement in, the following focused question was constructed 'Are dental prostheses made of PEEK inferior to those made of other materials in terms of clinical- and patient-reported outcomes?'. Outcomes such as implant-related complications, fractures, debonding of material stability were classified as clinical and those such as appearance and masticatory function were classified as patient-reported. Prior to beginning the literature search, eligibility criteria for research pertinent to this review were established. Randomised controlled trials (RCT), cohort studies, case-control studies and case reports that focused on reporting clinical and patient-reported outcomes of dental prostheses constructed with PEEK frameworks or major connectors were included.

**Literature Search-** An electronic literature search was conducted via PubMed/MEDLINE, Google Scholar, EMBASE and ISI Web of Science using the following medical subject heading (MeSH) keywords: ((polyetheretherketone) or (PEEK)) and ((denture) or (prosthodontic) or (bridge) or (denture framework) OR (dental prosthesis) OR (partial denture) or (complete denture) or (fixed denture) or (removable dental prosthesis) or (fixed dental prosthesis)) and the above-mentioned eligibility criteria for studies published between January 1990 and April 2022. Using the PICO principle, the data from each study were independently extracted by the two investigators using a pre-decided data collection form. Briefly, data corresponding to the following categories was extracted: the type of study, number of patients, type or brand of PEEK, the mean age or range of the age of the patients, rehabilitation and study group details, the fabrication details, dental implant details (number and dimensions), duration of the studies (follow-up) and the outcomes. (Table 1)

### **Results**

The initial search resulted in 72 items. In total, 57 irrelevant articles were excluded based on titles and abstracts and the full texts of 15 articles were downloaded to deem their eligibility for inclusion in this review. Of these 15 articles, three articles were excluded. Therefore, 12 studies were deemed suitable for inclusion in this review. Eight of the included studies were case reports, two studies were cohort studies, one study was a randomised controlled trial (RCT) and another one was a case-control study. Case reports documented six patients

who received single PEEK prostheses. The number of patients in the other studies ranged from 15 to 43. BioHPP PEEK was used to construct prostheses in five studies. PEEK Optima was used in the construction of prostheses in two studies and Ceramill PEEK was also used in two studies. While one study reported the use of the PEEK brand called Dental Direkt, two studies did not specify the type or brand of PEEK used. In four studies, removable PEEK dentures were constructed and fixed dental prostheses (FDP) were fabricated in three studies. In the case reports, PEEK dentures were successfully used for the oral rehabilitation of eight patients without any clinical or patient-reported complications. In one cohort study, 20% of the implant-supported PEEK overdentures failed due to loss of passive fit, peri-implantitis developed in two patients and two dentures had to be repaired. On the other hand, in a retrospective study, the 5-year survival rate of PEEK FDPs was reported to be 93.1%, which was statistically similar to the success rate of titanium FDPs which was reported to be 93.5%. In the case-control study, in which the ridge changes of individuals who wore PEEK dentures were compared to those who did not wear any dentures, there was no difference observed between the outcomes of both the groups. Two case studies received an overall grade of medium and the overall quality of six studies was graded as 'low'. All three observational studies and the only RCT received scores of 'medium'. (Table 2)

## Discussion

Several materials are used in the construction of dental prostheses. Conventional materials include acrylics (with or without metallic frameworks), alloys and porcelain fused- to-metal. However, studies suggested that these materials have a high percentage of failure or complications after five years of placement. Systematic review and meta-analysis of 32 studies have suggested that implant-supported fixed dental prostheses may have a failure rate of as high as 33.6% after 5 years.<sup>16</sup> Acrylic partial dentures, primarily used as interim prostheses, were reported to last 6 to 12 months. On the other hand, removable metal dentures were reported to have a 5-year survival rate of 75%. Although alloy and PFM prostheses were constructed conventionally to overcome the limited strength and fracture resistance of acrylics, they are unable to prevent alveolar bone loss most likely due to unfavourable stress distribution. Although using dental implants to retain dental prostheses results in lesser bone resorption, it does not prevent it completely. PEEK, with mechanical properties similar to that of cortical bone, is currently being studied as an alternative to conventional materials used in the fabrication of fixed and removable dental prostheses. Indeed, PEEK's flexural strength (183 MPa) was shown to be much higher than that of polymethylmethacrylate (PMMA; 84 MPa) in a recent *in vitro* investigation.<sup>17</sup> Similarly, in the case reports reviewed in this systematic review, favourable outcomes in the case reports reviewed in this systematic review suggest that PEEK is a promising material to replace PMMA as the material of choice to construct interim prostheses. Nevertheless, a higher cost of PEEK may limit its clinical usage. Furthermore, a lack of randomised clinical trials focusing on PEEK dental prostheses indicates that there the evidence to use PEEK is inconclusive. Other materials such as base alloys and acrylics have been used for a longer time and, hence, are reported in the literature significantly more compared to PEEK. Due to PEEK's tensile properties being similar to bone, mechanical properties

superior to those of conventional acrylics and due to its non-brittle nature, PEEK-based prostheses supported by dental implants may potentially survive longer than conventional implant supported dentures. Nevertheless, in the retrospective study by Wang et al., a 5-year survival rate of 93% for implant-supported was reported and none of the 331 implants placed failed. Nevertheless, in the PEEK group, there was significantly lesser vertical peri-implant bone loss observed (0.70 mm) after 5 years compared to the same around the implants placed under titanium prostheses (0.96 mm), which could be due to a reduced level of stress-shielding that was reported in prior finite element analysis (FEA) studies on PEEK prostheses. In the same study, however, there was no significant difference observed between the survival of PEEK and Ti denture frameworks.<sup>18</sup>

## Conclusion

The evidence to ascertain the long-term viability of PEEK-based dental prostheses is insufficient. The majority of the evidence regarding the outcomes of PEEK dental prostheses is obtained from case reports and non-randomised observational studies. Therefore, future studies should focus on conducting large-scale, multicenter trials to compare the survival rate of PEEK prostheses to that of conventionally available prosthodontic appliances.

## References

1. Skirbutis G, Dzingutė A, Masiliūnaitė V, Šulcaitė G, Žilinskas J. A review of PEEK polymer's properties and its use in prosthodontics. *Stomatologija* 2017;19(1):19-23.
2. Quinn JB, Sundar V, Lloyd IK. Influence of microstructure and chemistry on the fracture toughness of dental ceramics. *Dent Mater* 2003;19:603-11.
3. Green S, & Schlegel J. A polyaryletherketone biomaterial for use in medical implant applications. *Polym Med Ind Proc*, Brussels, 2001;14-15.
4. Toth JM, Wang M, Estes BT, Scifert JL, Seim HB, Turner AS et al. Polyetheretherketone as a biomaterial for spinal applications. *Biomater* 2006;27:324-34.
5. Kurtz SM, Devine JN. PEEK biomaterials in trauma, orthopaedic, and spinal implants. *Biomater* 2007;28:4845-69.
6. Pokorný D, Fulín P, Slouf M, Jahoda D, Landor I, Sosna A. Polyetheretherketone (PEEK). Part II: Application in clinical practice. *Acta Chir Orthop Traumatol Cech* 2010;77:470-8.
7. Ma R, Tang T. Current strategies to improve the bioactivity of PEEK. *Int J Mol Sci* 2014;15:5426-45.
8. Karan M, Dua JS, Sonia C, Priyanshu RS, Anuj A, Veenita S. Polyetheretherketone (PEEK) dental implants: A case for immediate loading. *Int J Oral Implantol Clin Res* 2011;2(2):97-103.
9. Stawarczyk B, Beuer F, Wimmer T, Jahn D, Sener B, Roos M, Schmidlin PR. 2013. Polyetheretherketone—A suitable material for fixed dental prostheses? *J Biomed Mater Res Part B* 2013;101B:1209-1216.
10. Sachin S, Cehreli MC, Yalcin E. The influence of functional forces on the biomechanics of implant supported prosthesis—a review. *J Dent*. 2002; 30:271-282.

11. Sarot JR, Contar CM, Cruz AC, De Souza MR. Evaluation of stress distribution in CFR-PEEK dental implants by the three-dimensional finite element method. *J Mater Sci Med.* 2010; 21:2079–2085.
12. Ozkurt Z, Kazzoglu E. Zirconia dental implants: A literature review. *J Oral Implant.* 2011; 37:367–376.
13. Schwitalla A, Muller WD. PEEK Dental Implants: A Review of the literature. *J Oral Implant.* 2013;39:743–749.
14. Yildirim M, Fischer H, Marx R, Edelhoff D. In vivo fracture resistance of implant-supported all-ceramic restorations. *J Prosthet Dent.* 2003;90:325–331.
15. Andreiotelli M, Wenz HJ, Kohal RJ. Are ceramic implants a viable alternative to titanium implants? A systematic literature review. *Clin Oral Implants Res.* 2009;20:32–47.
16. Pjetursson, B.E.; Thoma, D.; Jung, R.; Zwahlen, M.; Zembic, A. A systematic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) after a mean observation period of at least 5 years. *Clin. Oral Implant. Res.* 2012, 23, 22–38.
17. Mutneja, P.; Shrivastava, S.P.; Dable, R.; Raj, A.N.; Srivastava, S.B.; Haque, M. Comparison of Mechanical Properties of PEEK and PMMA: An In Vitro Study. *J. Contemp. Dent. Pract.* 2021, 22, 179–183.
18. Wang, J.; Wu, P.; Liu, H.-L.; Zhang, L.; Liu, L.-P.; Ma, C.-F.; Chen, J.-H. Polyetheretherketone versus titanium CAD-CAM framework for implant-supported fixed complete dentures: A retrospective study with up to 5-year follow-up. *J. Prosthodont. Res.* 2021, 66, 279–287.