

Clinical Assessment of the Performance of Single Unit PEEK Crown Restoration: An Observational Study

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Abstract

Aim: To evaluate the clinical performance and patient satisfaction of PEEK Crowns.

Material & Methods: This was a pilot study conducted on twenty patients who required crown placement (on vital/non vital tooth) in the posterior segment. This study was conducted over a period of 1 year in the Department of Maxillofacial Surgery, Narayan Medical College & Hospital, Sasaram, Bihar, India.

Results: A total of 25 participants received PEEK crowns, all of which had complete occlusal contact with the opposite arch. No participants were lost to follow-up during the observation period. Significant difference was seen between the periodontal status at baseline and at 1-year recall. At 3 months, 4 (17%) patients had mild inflammation, and at 6 months, 2 (12%) patients had mild inflammation and 2 (10%) patients showed moderate inflammation. This was statistically significant as well with $P = 0.038$.

Conclusion: Within the limitations of this study the following conclusions were drawn that the PEEK crowns demonstrated by the use of Modified Ryge's Criteria, its capability to produce quality prostheses that were rated satisfactory with a relatively low rate of fracture over the relative mean period of one year.

Keywords: Longitudinal studies, patient satisfaction, polyetheretherketone, resin cements

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Introduction

Excellent physical properties of dental ceramics such as esthetics, low thermal conductivity, biocompatibility, and wear resistance made them able to imitate natural teeth [1,2]. Because of these features, dentists have widely used dental ceramics in several rehabilitation procedures, including onlays, inlays, porcelain veneers, and crowns [3,4]. However, as with any other restorative material, it has some drawbacks, like fragility under superficial stress, friability before cementation and possible wear of

the antagonist dentition or restorative material [5,6]. The surface quality of a restoration is one of the most important aspects that figure their clinical success in the oral cavity. Restorations' surface quality is highly related to esthetic appearance, surface roughness, wear resistance, gloss, and mechanical properties of the restorations. [7,8].

Among these properties, surface roughness is to be considered as it has a major impact on the biofilm adhesion and maturation,

gingival irritation, recurrent caries [9, 10], and staining [11].

Polyetheretherketone (PEEK) is a synthetic, tooth colored polymeric material that has been used as a biomaterial in many medical and dental applications [6]. It can be modified easily by incorporation of other materials as carbon fibers, glass fibers or ceramic fillers [12].

Biocompatible High Performance Polymer (BioHPP) PEEK is 20% ceramic reinforced, semicrystalline, thermoplastic and radiolucent. It is characterized by low density, light weight, shock absorber, biocompatible and can be veneered with composite resin [13]. It is used for fabrication of frameworks for fixed and removable dental prostheses. BioHPP PEEK can be fabricated via CAD/CAM technology by milling PEEK blanks. It is also can be pressed by using granular or pellet-shaped PEEK. Such unique physical and mechanical properties may promote the BioHPP PEEK to be considered as a promising material for dental application [14].

Therefore, this study was conducted to evaluate the clinical performance and patient satisfaction of PEEK Crowns.

Material & Methods:

This was a pilot study conducted on twenty patients who required crown placement (on vital/non vital tooth) in the posterior segment. This study was conducted over a period of 1 year in the Department of Maxillofacial Surgery, Narayan Medical College & Hospital, Sasaram, Bihar, India.

The inclusion criteria considered for selection of the patients were that the tooth may be vital or nonvital which is periodontally healthy also with no signs of bone resorption or periapical pathology. Tooth with adequate occlusogingival height was considered. Patients having a complete dentition in the opposing arch were selected. Patients with unacceptable

oral hygiene, periodontal disease, and reduced crown length were excluded.

All procedures performed in the study were conducted in accordance with the ethical standards given in 1964 Declaration of Helsinki, as revised in 2013. For all of the twenty patients, the same procedure enlisted below was followed. Preoperative status of the gingival tissue of the tooth to be restored was assessed. Radiographs and diagnostic casts were made to analyze the periapical status and contour and height of the tooth, respectively. The tooth preparation was done according procedures were developed based on the guidelines given by Shillingburg et al. [15] The tooth to be restored was prepared with a chamfer finish line of 0.8–1 mm and an overall reduction of 2 mm. 1.5–2 mm of occlusal clearance was given. After tooth preparation was completed, isolation was carried out, and then, gingival retraction cord (Ultapak, USA) was placed using a cord packer into the gingival sulcus. This helped in achieving sufficient retraction following which impressions of the prepared tooth were made using stock trays loaded with putty (Dentsply Sirona, Germany) and light body elastomeric impression material (Reposil light body, Dentsply, USA). The impression of the opposing arch was made as well. Temporary crowns were fabricated using 3M ESPE PROTEMP 4. They were finished and cemented using noneugenol-based temporary luting cement (Provicol, Germany).

The patient was recalled at intervals of 3 months and 6 months and 1 year. At the recall intervals, the restorations were evaluated using modified Ryge's criteria. [16] At the recall visit of 1 year, the crowns were evaluated on the same basis as done on the previous two recall visits and the patients were asked to fill a self-administered questionnaire developed for this study to assess their level of satisfaction, on a 5-point Likert scale.

Patient satisfaction was evaluated using this questionnaire that allowed patient to grade their fixed crowns according to a scale from 1 to 5, in which 1 was least favorable. The data were thus recorded and evaluated. The data obtained was systematically organized, and statistical analysis was carried out.

Results:

A total of 25 participants received PEEK crowns, all of which had complete occlusal contact with the opposite arch. No participants were lost to follow-up during the observation period.

The survival rate at 1 year was 93%. There was no fracture of framework that had to be replaced during the observation period. A modified Ryge’s rating of satisfactory was given for 100% of the crowns at all examinations.

Significant difference was seen between the periodontal status at baseline and at 1-year recall. At 3 months, 4 (17%) patients had mild inflammation, and at 6 months, 2 (12%) patients had mild inflammation and 2 (10%) patients showed moderate inflammation. This was statistically significant as well with P = 0.038 [Table 1].

Table 1: Scores recorded at various time intervals

	Anatomic form		Staining			Periodontal status				Marginal discoloration		Color match		Surface roughness		Marginal adaptation			
	I	II	III	I	II	III	IV	I	II	III	IV	I	II	I	II	I	II		
Baseline	100		-	100	-	-	-	100	-	-	-	100	-	100	-	100	-	100	-
3 months	95	5	-	85	15	-	-	85	15	-	-	80	20	100	-	95	5	100	-
6 months	95	5	-	85	15	-	-	80	15	5	--	80	20	100	-	95	5	100	-
1 year	90	10	-	85	10	5	-	60	30	10	-	80	20	95	5	95	5	85	15

Patient satisfaction regarding esthetics and comfort was positive at all examinations. All patients had graded the prosthesis with a score of 3–5 on an average [Table 2].

Table 2: Patient satisfaction scores

	Very bad	Bad	Average	Good	Excellent
Chewing efficiency	0	0	25	50	35
Color match	0	0	15	35	65
Contour	0	0	0	55	40
Comfort	0	5	0	40	50

Three patients (20%) reported of sensitivity/pain in the tooth but no changes were seen periapically [Table 3].

Table 3: Patients evaluation of sensitivity

	Present	Absent
Sensitivity	80	20

Discussion:

Delineated loss of the glaze layer or roughening of polished surfaces are the result of ceramic surfaces grinding, the subsequent use of a polishing set is a well-settled method, but is not applied by all dentists. Differences in physical properties

and composition of restorative materials and tooth substances lead to differential wear with time. This mismatch of wear rate may lead to either excessive wear of the natural dentition or the opposing restorative material and may cause tooth

sensitivity, occlusal destabilization, or loss of esthetics [17-20].

Regarding fracture (mechanical failure), there was no statistically significant difference between the 2 groups over the follow up year. All the PFM crowns survived with alpha score without any evidence of fractured veneering porcelain. On the other hand, 2 BioHPP PEEK crowns showed occlusal fracture of the veneering composite resin after 6 and 10 months. These fractures may be due to weak bond strength of PEEK framework to veneering composite resin, owing to its hydrophobic, chemically inert surface and its resistance to surface modifications by different chemical treatments. These fractures may be also due to low wear resistance of the veneering composite in comparison with the veneering porcelain in the PFM crowns or presence of occlusal prematurities or interferences in centric or eccentric occlusion.

This might be in accordance with Nazari et al. in 2016 [21] and Taufall et al. in 2016 [22] who found that the failure mode of all PEEK restorations was adhesive between the frameworks and the veneering composite. This was also in agreement with Sulaya and Guttal in 2020 [23] who suggested that the cause of the PEEK fracture may be due to localized biting forces, premature contact.

Superficial analysis and screen of glass ceramics was allowed by measuring roughness with regard to their surface characteristic after being finished [24]. Surface roughness can be described by several linear (R_q , R_q , R_a) or three-dimensional (S_z , S_q , S_a) parameters [25-27]. R_a , which can be defined as the mean arithmetical value of all the absolute distances of the profile inside of the measuring length [28] was measured because it is the most commonly used parameter for evaluating the effect of finishing protocols on dental ceramics [29-30]. Quantitative assessment of tooth wear has most often been assessed using surface

profilometry. This has the benefit of being simple to understand, reasonably straightforward to conduct, as it allows a step measurement (in microns) of surface roughness and enamel loss. [31]. (Rodriguez et al. 2010) [32] demonstrated that the 3D analysis provided more sensitivity maybe due to scratches induced by the stylus of contact profilometry.

Patient satisfaction in this study was considered, and on an average, around 50%–60% of the participants had given a score of 5 (excellent) and around 20%–30% scored it at 4 (good) and around 10%–20% scored it at 3 (average). In a previous study done on zirconia, 72% of the participants scored it at 1 (excellent) and 18% scored it at 2 (good). [33] In this study, 20% of the patient complained of sensitivity with respect to the tooth. No clinical evidence was found to confirm the same. In a similar study evaluating Lithia disilicate crowns, 5% of participants reported of sensitivity, and in a study done on all ceramic bridges, 3 out of 37 patients complained of sensitivity. [33-35]

Conclusion:

Within the limitations of this study the following conclusions were drawn that the PEEK crowns demonstrated by the use of Modified Ryge's Criteria, its capability to produce quality prostheses that were rated satisfactory with a relatively low rate of fracture over the relative mean period of one year.

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