



# Patient Satisfaction and Prosthetic Complication of PEEK Composite Maxillary Fixed Full Arch Prosthesis opposing Mandibular Distal Extension Partial Denture: an Observational Study

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## ABSTRACT

**Objectives:** This study aimed to evaluate patient satisfaction (VAS) and prosthetic outcomes of polyether ether ketone (PEEK) fixed prostheses supported by six maxillary implants and opposed by distal extension removable partial denture.

**Materials and methods:** six participants with edentulous maxillary and distal extension mandibular ridges received six implants according to the All-on-6 treatment concept. After 6 months, patients received PEEK framework veneered with composite teeth. Patient satisfaction was evaluated using visual analogue scale (VAS) and Prosthetic complications were measured on the patient and implant levels after six months.

**Results:** There was overall patient satisfaction from the PEEK fixed prosthesis and The most frequent complications were veneer fracture on the patient level and prosthetic screw loosening on the implant level.

**Conclusion:** Within the limitations of this study, the PEEK framework veneered with composite may be a suitable treatment option for All-on-6 implant rehabilitation in patients with maxillary edentulous arches opposed by distal extension mandibular ridges, as it was associated with higher patient satisfaction and prosthetic outcomes after six months. However, it was associated with an increased rate of veneer or artificial gingival fracture.

**Key Words:** All-on-6, fixed prosthesis, implant, PEEK, patient satisfaction.

## I. INTRODUCTION

The majority of people who wear complete dentures struggle with a progressive loss of retention and stability during mastication and phonetics, which led patients to request a fixed rehabilitation.(1) The way partial and completely edentulous patients are cared for using prosthesis in dental practice has altered thanks to endosseous dental implants. With the reported survival rate of dental implants being above 90 percent after at least a 5-year follow-up period, the use of

endosseous dental implants has come to be recognized as a standard clinical approach. The favorable long-term outcomes of dental implant therapy have been recognized as well in the scientific literature. (2)

Maxillary edentulous patient restoration with implants is typically more challenging than mandibular arch replacement due to anatomical, biomechanical, and aesthetic difficulties. According to the Lekholm-Zarb classification, the maxillary bone density is mostly grade 3, whereas the mandible is typically grade 2, which has been associated with primary implant stability.(3, 4) The number of implants utilized per arch varied considerably in early publications and was inconsistently reported on Brånemark's configuration proposed using six implants for the maxilla and five implants for the mandible to stabilize a fixed, full-arch prosthesis, with all implants distributed anteriorly, mounted parallel to one another, and splinted together through a passively fitted prosthesis.(5)

Different prosthetic designs and materials are now obtainable, depending on whether the implant-supported fixed prosthesis is temporary (provisional) or permanent (final).(6, 7) As a result of the recent improvements in dentistry, metal-ceramic restorations on implants are used in place of metal-acrylic restorations, to address the shortcomings of metal-acrylic restorations.(8) Nowadays, new materials are utilized to create these prostheses, including: monolithic zirconia, ceramic-veneered zirconia, ceramic-veneered titanium, lithium disilicate, hybrid ceramics, milled PMMA (poly methyl methacrylate), PEEK (polyether ether ketone), or 3D-printed resins, which all exhibit favourable biological and mechanical properties. (9)

The polyaryletherketone group's polyetheretherketone (PEEK) is a high-performance polymer that possesses excellent physical and chemical characteristics such as low specific weight (1.3 g/cm<sup>3</sup>), low flexural strength



(165-170 MPa), appropriate elasticity (3,600 MPa), and appropriate hardness (20 HV).(10)

PEEK has been widely employed as a biomaterial in orthopaedics fields since its biocompatibility and mechanical behavior were established. The main benefit of this material is that it has a lower elastic modulus than metallic materials and one that is somewhat close to that of human bone, which enables it to relieve stress on the surrounding bone. PEEK has increasingly being used for both permanent and removable prostheses due to its distinctive white appearance and mechanical properties.(11), especially for implant CAD-CAM frameworks(12). PEEK has been shown to act as a stress breaker to lessen the stresses transmitted to the bone-implant interface. (13).

PEEK has been suggested in certain clinical studies as a suitable framework material for ISFCDs.(13, 14). In order to evaluate the clinical results of full-arch implant-supported fixed hybrid PEEK-acrylic resin prosthesis, Maló et al. (15)carried out a brief prospective cohort research.Due to their improved mechanical qualities, these clinical findings and investigations suggest that implant supported fixed prostheses (ISFCDs) with a PEEK framework are a preferable replacement for the traditional complete-arch implant-supported fixed hybrid titanium prosthesis approaches.Studies assessing the reliability of this material in ISFCDs, particularly those with long-term follow-up, are scarce.

Reviewing the literature, the use of PEEK material for Allon-6 implant-supported fixed restorations is relatively limited. Additionally, the evaluation of patient satisfaction and prosthetic outcomes of this material was uncommon. Accordingly, this study aimed to investigate patient satisfaction and prosthetic outcomes of PEEK fixed prostheses for maxillary All-on-6 implants.

## II. MATERIALS AND METHODS

### Participants and Study Design

- Six patients were selected for this study from a previous study who had already received previous implants in the maxillary arch which opposing distal extension mandibular ridges (class I Kennedy; the remaining dentition included the anterior teeth only or anterior teeth and first premolars)mandibular fromthe department of removable prosthodontics, Faculty of Dentistry, Mansoura University. The patients were fully informed about the procedures that will be done. The inclusion criteria were as follows: (1) patients

complaining about looseness of maxillary dentures and preferring fixed prostheses (2) patients free from any chronic systemic diseases. Patient's general condition including blood pressure, pulse rate and respiratory rate were evaluated by a physician. Also, laboratory investigations were performed such as complete blood picture and blood glucose level (3) Patient who was motivated, agreed with the follow-up visits and willing to return for follow-up appointments. The exclusion criteria were as follows: (1) Patients with relative contraindication such as uncontrolled diabetes mellitus, moderate smoking and alcoholism, patient with TMJ disorder and heavy smokers for more than 10 cigarettes per day (2) Uncooperative patient

### Prosthetic Procedures:

After six months of osseointegration period,the cover screws were unscrewed, and the healing abutmentswere screwed into the implants for 2 weeks. (Fig.1) The denture base was relined in the areas of the healing abutments and tested against the abutments with no rocking or interference. The denture was relined again with silicon soft lining material and the patient was instructed to wear the denture for two weeks. After two weeks, the healing abutments were unscrewed. Transfer copings were screwed to the fixtures for open tray impression. (Fig.2)

Perforated plastic rigid disposable tray was modified with six holes in areas corresponding to implant sites and inspected intraorally to ensure that the direct transfer copings freely protruding from the tray and not interfering with the tray insertion and removal. (Fig.3)Splinting of the transfer copings was done using ligature wire and clear duralay resin material.Maxillary impression was recorded using silicon heavy and light body rubber impression material according to the one step technique. The impression posts were unthreaded and the tray with the transfer copings included within the impression material was removed from the mouth as one unit.

The impression posts were used to connect analogues to the transfer copings and the tray was boxed and poured with gingival mimic material over the alveolar ridge then poured in stone in two-step pour technique to construct the master cast. (Fig.4)



Fig.1



Fig.2



Fig.3



Fig.4

#### Construction of the prosthesis:

Verification jig was constructed on the cast by splinting the copings with dental floss and Dura lay resin was placed over the floss. Once resin was polymerized it was finished and polished then disk was used to section each of copings from one another. (Fig.5) The verification jig was then tried in the patient mouth then Dura lay resin was used to reconnect transfer copings together. (Fig.6) Maxillary record block was made to record maxillo-mandibular relation with the mandible. (Fig.7) The vertical dimension was adjusted, and centric relation was recorded. Setting of six anterior teeth was done on the record block and try in was carried in the patient mouth to check vertical dimension and lip support.(Fig.8)Then the setting of the remaining teeth was carried out, then try in was sent to the lab.

- Fabrication of the peek framework was done in the lab as follow:
- Wax model was fitted on the master cast.

- Then, it was connected to cylindrical reservoir of the Moldplate (A mold temperature of 160°C to 190°C (320°F to 374°F) is recommended when using PEEK, as this will help minimize warping and yield optimal crystallization) to construct the peek framework by injection molding technique according to Pacurar et al (16)
- The framework was de-invested, finished and tried intraorally.
- The prosthesis (peek framework with composite) was seated and stabilized in the mouth; then the patient was gently guided into centric occlusion to verify the occlusion and adjust any premature occlusal contacts. The prosthesis was screwed in its place and the holes opposing the screw opening were closed using composite. (Fig. 9)
- Panoramic x-ray was done to make sure that the prosthesis was in its place.

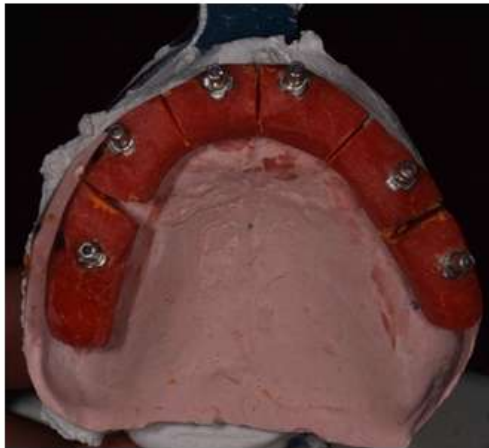


Fig.5



Fig.6



Fig.7



Fig.8



Fig.9

#### Evaluation of patient satisfaction:

##### Patient Satisfaction (VAS):

- Patient satisfaction was evaluated using a questionnaire based on visual analogue scale (VAS). Patients were asked to mark their

answer (amount of satisfaction) on a 100- mm line (with zero refers to not satisfied at all and 100 refers to completely satisfied). The mean of the answers (length of the lines from zero to the marks in mm) for each question was



subjected to statistical analysis. The VAS questionnaire addresses several items of patient satisfaction that are not covered by domains of OHRQoL.(17) The questions cover several items related to maxillary overdentures such as retention, stability, comfort, ease of cleaning, ease of speaking, ease of chewing, limited activities due to embarrassment, quality of bolus, and appearance. The questions of VAS were given to the patients in Arabic.

#### Evaluation of prosthetic aspects and complications:

The prosthodontic maintenance and complications for implantsupported fixed prostheses were recorded after 6 months of function including : The incidence (percentage) of the following prosthetic complications were measured for definitive restorations: (1) on the patient level—prosthesis fracture, ceramic/composite veneer fracture, and artificial gingiva fracture; (2) on the abutment level—

cylinder fracture, abutment fracture, abutment screw loosening/fracture, and prosthetic screw loosening/fracture.

#### Observational analysis

It is an observational study wherethe VAS data was parametric and met normal distribution. The prosthetic complication data were non parametric. The descriptive statistics of VAS data including mean, and standard deviation.

#### Results

##### Regarding VAS score,

- Vas questions are presented in table 1.
- there was high significant patient satisfaction regarding the following questions satisfaction\_maxillary\_prosthesis, occlusion, comfort, ease\_of\_speaking, and satisfaction\_with\_healing, satisfaction\_maxillary\_prosthesis\_compared\_to\_natural\_teeth, ease\_of\_chewing, ease\_of\_cleaning and appearance,

Table 1

	PEEK composite	
	<i>X</i>	<i>SD</i>
satisfaction_maxillary_prosthesis	88.4	3.55
satisfaction_maxillary_prosthesis_compared_to_natural_teeth	93.43	2.99
occlusion	98.1	3.62
comfort	92.43	2.62
ease_of_chewing	94.77	1.63
ease_of_speaking	94.1	2.75
ease_of_cleaning	92.43	2.62
appearance	95	2
satisfaction_with_healing	88.43	3.61



**Regarding patient complications**

- The incidence and percentage of prosthetic complications on patient level and implant level is presented in table 2.

**On patient level**

- Artificial\_gingival\_fracture occurred in one patient (16.6%),Decementation\_of\_teeth occurred in in one patient (16.6%), and Veener\_fracture\_separation occurred in two patients (33.3%)
- On the other hand, there was no prosthetic\_fracture noted on patient level.

**On implant level**

- Abutment\_screw\_loosening occurred 4 times in 2 patients (11.1%), Prosthetic\_screw\_loosening occurred 2 times in 3 patients (5.5%), and Cylinder\_fracture\_separation occurred 2 times in 2 patients (5.5%).
- There was no complication regarding abutment\_fracture, abutment\_screw\_fracture, and prosthetic\_screw\_fracture.

**Table.2**

PEEK		
Composite		
	incidence	%
<b>Patient level</b>		
Prosthetic_fracture	0	0%
Artificial_gingival_fracture	1	16.6%
Decementation_of_teeth	1	16.6%
Veener_fracture_separation	2	33.3%
<b>Implant level</b>		
Abutment_fracture	0	0%
Abutment_screw_loosening	4	11.1%
Abutment_screw_Fracture	0	0%
Prosthetic_screw_loosening	2	5.5%
Prosthetic_screw_fracture	0	0%
Cylinder_fracture_separation	2	5.5%

**III. DISCUSSION**

The All-on-6 PEEK fixed maxillary prosthesis received an overall patient satisfaction score (VAS) during a period of six months. When compared to other treatment options like complete dentures or implant overdentures, fixed prostheses may be seen as being relatively close to a patient's own natural dentition, which may explain why they received higher satisfaction ratings for maxillary prosthesis,

maxillary prosthesis compared to natural teeth, occlusion, comfort, and ease of speaking. This was in line with research by Maló et al. (15), who claimed that the All-on-4 PEEK fixed maxillary prosthesis had a 100% implant survival rate.

The exact patient selection criteria, accurate case diagnosis, thoughtful treatment plan, precise surgical procedures, appropriate selection of implant system with advanced double grip surface enhancing osseointegration, delayed



loading of the implants after guaranteeing successful osseointegration, and adequately designed and efficiently constructed prostheses can all be related to these high patient satisfaction rates.

The ease of cleaning and comfort of the PEEK fixed maxillary prosthesis were extremely high, which may be related to PEEK's decreased tendencies for plaque buildup. (18) The findings of Klur et al. (19), PEEK-made restorations offer a good and stable alternative to CoCr-made restorations, especially when it comes to enhancing oral hygiene. Additionally, during a masticatory simulation, Wachtel et al. (20) assessed the microbiological tightness of screw-retained PEEK crowns on titanium implants. They discovered that the PEEK material had a sealing impact to stop bacteria from leaking at the implant-abutment interface. Compared to superstructures composed of conventional materials, this provides advantages.

PEEK materials are non-allergenic, lightweight, and biocompatible in terms of comfort. Compared to metal alloys, less biofilm accumulates on their surfaces. This means that PEEK, when combined with high-strength veneering glass-ceramic for implant supported prostheses, can provide an effective metal alternative as a framework material, especially in the high-stress bearing areas. Both materials may provide a more viable alternative to metal as well as zirconia for a framework material, according to multiple review papers. (21).

The engineering of the prosthesis, thorough treatment planning, and the excellent biomechanical properties of the prosthetic elements may all be held responsible for the relatively low occurrence of prosthetic problems and maintenance on the patient level. Additionally, the elimination of patients who exhibited parafunctional behaviours is responsible for this outcome. Parafunctional habits are regarded to be a substantial contributor to prosthetic fracture and failure because they place massive load on the prosthesis. (22)

Conversely, there was a noticeably high rate of composite veneer fracture/separation. Another study made a similar conclusion. (15) This might be a consequence of the PEEK material's limited wetting capabilities, which may be the cause of the composite's insufficient strength in binding to the PEEK frame. (23) Additionally, the low PEEK frame resistance to bending and plastic deformation (24) could possibly be a contributing factor in the elevated frequency of veneer fracture.

Regarding the incidence of gingival composite chipping on PEEK, this may be because it is difficult to bond composite firmly to the PEEK

framework, as was noted in a prospective cohort clinical study (15), which found that bonding to the PEEK substructure was the most challenging situation and that it represented a predominant mechanical challenge.

The reduced elastic modulus of PEEK, which increases the amount of stresses on the screws, may be the cause of a higher prevalence of prosthetic problems at the implant level, specifically abutment screw loosening in the PEEK fixed prosthesis. (25) The small percentage of prosthetic screw loosening can be attributed to the poor passive fit and increased stress distribution from the mandibular natural teeth to the maxillary prosthesis. However, the few instances of cylinders separating from the PEEK frame may be caused by the resin cement's lack to adhere.

The limitations of this study are the relatively small sample size, short duration of the study and the lack of repeated measurements of patient satisfaction and prosthetic complications on different time interval as time may influence the results of the prosthetic complications and patient satisfaction.

#### IV. CONCLUSION:

Within the limitations of this study, the PEEK framework veneered with composite may be a suitable treatment **option** for All-on-6 implant rehabilitation in patients with maxillary edentulous arches opposed by distal extension mandibular ridges, as it was associated with higher patient satisfaction and prosthetic outcomes after one year. However, it was associated with an increased rate of veneer or artificial gingival fracture.

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