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EVALUATION OF GINGIVAL HEALTH OF ABUTMENTS USING POLY ETHER ETHER KETONE (PEEK) OVERDENTURE: A RANDOMIZED CLINICAL TRIAL

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ABSTRACT

AIM: This study aims to evaluate the effect of using PEEK material on gingival health of the overdenture abutments.

Materials and Methods: Twelve patients with remaining two mandibular canines will be selected (from the outpatient clinic of Prosthetic department Faculty of Oral & Dental medicine, Cairo University) to participate in this study and divided randomly into two groups. Group I patients will receive mandibular overdenture constructed from Polymethyl methacrylate (conventional) acrylic resin (control group). Group II patients will receive mandibular overdenture constructed from PEEK. All patients will be evaluated for abutments' gingival health in form of pocket depth, gingival index and gingival fluid at overdenture insertion as a baseline, 3 month and 6 months after insertion.

Results: The gingival index scores, pocket depth recordings and gingival fluid evaluation showed that abutments of group II were gingivally healthier than abutments of group I.

Conclusion: The PEEK material is considered a promising material for preserving the the retained dentition underneath the Overdentures.

KEYWORDS: PEEK, Overdentures, abutments' preservation, gingival health, denture materials

INTRODUCTION

Polymethylmethacrylate (PMMA) Acrylic resin has been commonly used as the denture base material since 1930s.

The polymethylmethacrylate was adopted due to its physical properties concerning biocompatibility, dimensional stability, mechanical properties and excellent aesthetics as well as its ease of fabrication and low cost. (1-5)

In overdentures cases, the presence of prepared abutments which are accompanied with dental plaque alter the condition. The overdentures'

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material fitting surfaces should seek robust antimicrobial properties not permitting bacteria or microorganisms to cling to its outer layer, to prevent a diversity of clinical problems including denture stomatitis and peri-abutment mucositis [6-8]

Margin gingivae of remaining overdenture abutments health should not be impaired by the prosthesis to ensure longevity of the treatment plan. [9-10]

PEEK, was developed in 1978, A polyaromatic nearly-crystalline thermoplastic polymer and in 1990s was introduced as the safest scientifically biomaterial in orthopedic surgeries and eventually as implants, in partial denture prosthetic components and even the antral portion of a maxillary obturator prosthesis [11-15]

The phenylene rings are non-reactive, the ketone group offers rigidity and the ether group flexibility caused the PEEK material a great resistance against attack by chemicals and shock absorpting action.[16-19]

PEEK showed higher wear resistance than resin materials, on lateral abrasional forces, while still being a lightweight material of low density. [20]

PEEK is manufactured by conventional methods like compressed molding and injection molding or CAD/CAM technology, and both techniques showed accepted clinical fit. [21-22]

In obrurator prostheses it's digital design showed excellent adaptations to subjects anatomy maximizing patient comfort also due to its non-allergenic nature lacking thermal and electrical conductivity. [23]

It was reported Zoidis et al. (24) that PEEK and acrylic teeth can serve together as partial denture prosthetic components, having low water absorption properties and remarkable resistance to corrosion and deterioration [25-27]

To enhance the surface energy of PEEK it was advised to perform conventional sanding or etching by acid or laser. [28]

The aim of this study is to assess the gingival health of overdenture abutments using PEEK material in the overdenture prosthesis.

MATERIALS AND METHODS

This study is a randomized clinical trial conducted on twelve male patients presented in the outpatient clinic in Prosthodontic department, faculty of oral and dental medicine, Cairo University.

Selection of patients:

Inclusion criteria:

- patients selected requiring mandibular overdentures supported on remaining mandibular bilateral canines
- patients enrolled if they aged from 50 to 65 years
- the remaining bilateral mandibular canines teeth were sound, periapically, gingivally and periodontally healthy.

Exclusion criteria

- Patients Involved with poor oral hygiene or any systemic disease or consumption of medications affecting gingival health were excluded
- Patients having Parafunctional habits that may affect occlusal loads were excluded

Gingival health Assessment:

Generally, gingival health can be primarily assessed by inspecting the color, whether the gingiva is edematous, and whether the gingival margin is knife-edge in form, along with any discomfort or tenderness the patient is experiencing.

Measuring the gingival health of the abutments was performed by using the following indices:

- Gingival index scores
- Gingival fluid
- Pocket probing depth (PPD). This was measured by using the graduated probe (William's probe),

from the free gingival margin to the depth of the gingival/periodontal pocket, circumferentially around each abutment.

- Bleeding on probing (BOP): It is one of the reliable scores that indicates the presence or absence of gingival inflammation. It is carried out by using the periodontal probe and applying a gentle pressure of 0.25N to the depth of the sulcus in 4 to 6 sites of the abutments. It is a dichotomous score (absence or presence) of bleeding within the 10 seconds after pressure application to the sulcus.
- All these records and scores were measured for all subjects at baseline, before the delivery of the mandibular overdentures and later 3 and 6 months after delivery of overdentures.

Grouping:

Patients were randomly divided into two groups:

- Group I: Received mandibular overdenture constructed conventionally in acrylic resin.
- Group II: Received mandibular overdenture constructed with acrylic resin lined with a PEEK portion opposite to the abutments areas.

Mandibular Overdenture procedures:

- **For both groups:** Bilateral mandibular canines were prepared to serve as Overdenture abutments after root canal treatment was successfully done.
- Conventional procedures involving impressions makings and bite registerations were done reaching the waxed-up try-in stage, all mandibular master casts were modified to be relieved (creating space) at regions of the free gingiva surrounding the prepared mandibular canine abutment teeth.
- **For Group I:** The trial dentures were flasked, processed in conventional acrylic resin mandibular overdentures then were finished and polished in the conventional manner.
- **For Group II:** PEEK polymer was incorporated in the construction of the mandibular overdentures.
- Preparation and Casting of the Peek

For PEEK portion preparation, the procedure used a wax pattern as an analog. The Wax pattern was created directly on mandibular master cast (modified after creating space at regions of free gingiva).

Mold is obtained in phosphate-bound investment material specially used for PEEK pressing.

Melting of peek granules was done and vacuum pressing of the peek was done. [29,31,32,33]

After obtaining PEEK polymer:

All peek portions at the inferior surface (to be in contact with oral tissues) were polished with silicon carbide paper under rinsing water for 10 seconds on a 300 rpm in order to provide a uniform surface. While PEEK portions at the upper surface (to be in contact with overdenture) were roughened to create mechanical locks with the acrylic resin material then the whole PEEK portions were then ultrasonically cleaned for 3 minutes and then dried with air [29,31,32,33]

Fig. (1) Wax pattern in mold

Fig. (2) Peek portion after construction

Fig. (3) Peek portions attached to fitting surface overdentrure

Application of Heat Cured Acrylic Resin:

The PEEK polymer portions together with adjusted try-in assemblies were flasked in a standard flasking technique for acrylic dentures with dental stone and then were dewaxed and cleaned using boiled water [30].

The heat cured acrylic resin was mixed and was packed by placing the flask in a hydraulic press [34].

All the mandibular Overdentures were heat processed according to the manufacturer‘s instructions, and then the flasks were cooled slowly at room temperature [35]. After deflasking, all the overdentures were immersed for 24 hours in 37°C water

Delivery of all twelve mandibular overdentures after adjustments done for all occlusal premature interferences (Essam 53) and assuring all patients to follow a strict oral hygiene program.(Essam 4) w up measurements:

Measurements done for Gingival index, pocket depth and gingival fluid for all abutments.

All parameters were recorded at delivery, three months and six months after delivery.

Statistical analysis:

The results obtained were recorded as mean values.

RESULTS

Table 1: Mean value and standard deviation of the gingival index scores, at the time of the overdenture delivery, 3 and 6 months later, among Group I and II subjects.

TABLE (1) Shows that Group II had gingivally healthier abutments as it measured 0.33 while in Group I measured 1.5 and this statistically significant difference. (Table 2)

	At Delivery Mean ± SD	3 months later Mean ±SD	6 months later Mean ±SD
Group I	0.21±0.41	1.00±0.59	1.50±0.51
Group II	0.33±0.48	0.38±0.49	0.33±0.48

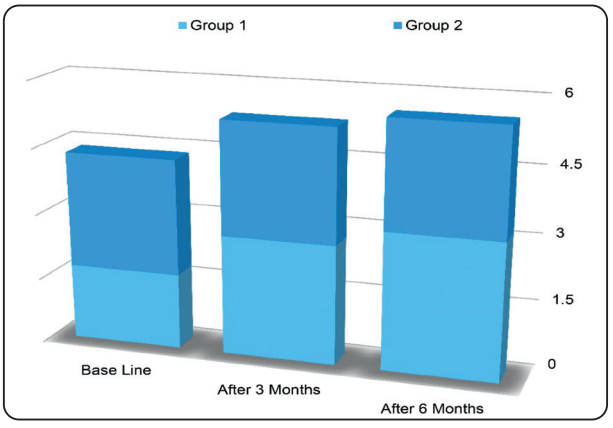

Fig. (4) Mean value and standard deviation of the gingival index scores, at the time of the overdenture delivery, 3 and 6 months later, among Group I and II subjects

TABLE (2) Results of analysis of variance with repeated measurements:

Effect	P-value	Significance
Time	<0.001	Yes
Time*Group	<0.001	Yes

TABLE (3) Mean value and standard deviation of the pocket depth measurements, at the time of the overdenture delivery, 3 and 6months later, among Group I and II subjects.

	At Delivery Mean ± SD	3 months later Mean ±SD	6 months later Mean ±SD
Group I	1.72±1.09	2.72±1.30	3.13±1.44
Group II	2.62±1.23	2.58±1.26	2.44±1.10

Table 3 shows that an increased pocket depth happened in abutments of Group I and Group II after 6 months of overdenture delivery 3.13,2.44 respectively.

TABLE (4) Results of analysis of variance with repeated measurements:

Effect	P-value	Significance
Time	<0.001	Yes
Time*Group	<0.001	Yes

Table 4 shows that there is a statistically significant difference in pocket depth increase between the two groups.

TABLE (5) Mean value and standard deviation of the gingival fluid, at the time of the overdenture delivery, 3 and 6 months later, among Group I and II subjects.

	At Delivery Mean ± SD	3 months later Mean ±SD	6 months later Mean ±SD
Group I	43.1±15.7	78.1±27.9	118.8±33.6
Group II	71.6±33.1	67.2±34.5	68.5±32.4

TABLE (6) Results of analysis of variance with repeated measurements:

Effect	P-value	Significance
Time	<0.001	Yes
Time*Group	<0.001	Yes

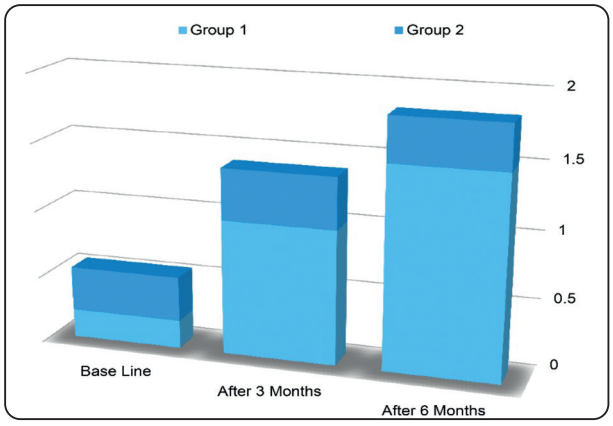

Fig (5) Mean value and standard deviation of the pocket depth measurements , at the time of the overdenture delivery, 3 and 6 months later, among Group I and II subjects.

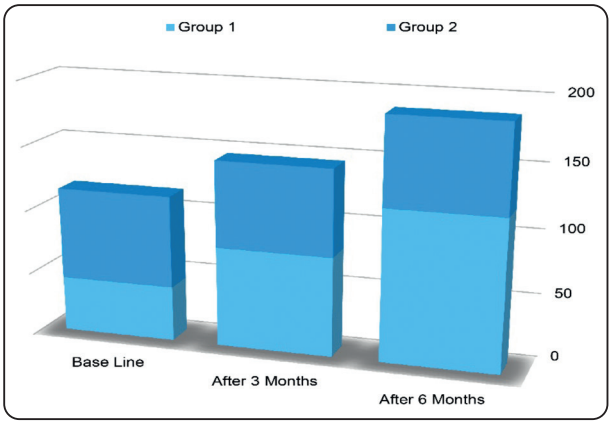

Fig. (6) Mean value and standard deviation of the gingival fluid, at the time of the overdenture delivery, 3 and 6 months later, among Group I and II subjects.

DISCUSSION

The mandibular overdentures were relieved during construction at the gingival marginal areas and also undergone occlusal adjustments to eliminate any traumatic effects on the investigated tissues (Essam 53) [36]

On the day of delivery patients were instructed to follow a strict oral hygiene routine to reduce the effect of plaque accumulation on the periodontal health. [37]

It was well noted that there is a strong relation between gingival fluid flow and the gingival inflammation degree as well as the gingival fluid flow is correlated to the pocket depth. [38,37]

Researchers claimed that using PEEK assisted in the preservation of the abutments' gingival health and periodontium. [39,40]

PEEK's biochemical makeup and polymer branching architecture made it stable at high temperatures [41] optimally needed to withstand overdenture construction procedures.

The low elastic modulus of PEEK "Young's modulus", great flexural strength and creep resistance suggested ultrahigh performance to reduce fragility of an acrylic overdenture i.e: PERK deforms but does not break. ([42,43,44,45] <Moreover PEEK has its surface modified to bond with resin [46]

From the analysis of the results of this study it is evident that Group I subjects showed a marked increase in all the investigated parameters throughout the different study periods relative to Group II subjects. This increase when statistically analysed was found to be highly significant ($P < 0.001$), and that was attributed to the PEEK's high biocompatibility and chemical stability as it was found to show lower affinity for plaque and biofilm when compared to resins and metals. [17,18,19] [13,14,15]

CONCLUSION

The PEEK material is considered a promising material that can be used in various dental practice applications. When used in this study as an over-denture material, it proved to enhance the health of the gingival health and periodontium of the involved teeth. PEEK has adequate strength, rigidity, and elastic modulus; due to these properties, it is nowadays replaced by other dental materials that have been used for a long time. Studies need to be conducted to utilize this high-quality material.

Conflict of Interest:

The authors declare no conflict of interest.

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Ethics:

This study protocol was approved by the ethical committee of the faculty of dentistry- Cairo university on: October 2024, code: 581024

Data Availability:

Data will be available upon request

Clinical trial registration:

The protocol for this study was registered on clinicaltrials.gov, under ID:……..

Author contributions and Credit statement:

Author 1: Data curation, Writing - review & editing, Writing - original draft, Methodology, Conceptualization, Resources.

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