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Two Different Removable Partial Denture Framework Materials for Lower Kennedy class II

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Abstract:
Background*: This clinical study aimed to compare between Cobalt chrome and poly-ether-ether-ketone material in the fabrication of a mandibular Removable Partial Denture Kennedy Class II clinically and radiographically.*
Materials and Methods*: In this prospective randomised controlled study, fourteen patients having mandibular Kennedy Class II RPD (missing from 6 to 8 at one side) were selected from those attending to the Outpatient Clinic of The Prosthodontics Department, Faculty of Dentistry, Tanta University. These patients were divided randomly by coin flipping into two groups, each group consists of seven patients:*
Group A: Seven patients received cobalt chrome (CO-CR) removable partial denture using conventional method.
Group B: Seven patients received RPD fabricated from poly-ether-ether-keton (PEEK) (BioHPP) using lost wax technique.
The abutment tooth was evaluated clinically and radiographically. Clinically by using periodontal probe in measuring pocket depth and clinical attachment level, and the periotest was used to measure tooth mobility. Radiographically by using digital periapical x-ray. After insertion of denture framework in patient mouth, the abutment tooth was evaluated at the baseline, 3, 6 and 9 months clinically and radiographically.
Results*: There was a significant difference in all durations of metal and no significant difference between durations in PEEK in pocket depth and clinical attachment level. For assessment of tooth mobility, there was a significant difference between baseline with 9 months and between 3 months with 6 months in metal. The bone loss was greater in Co-Cr more than that was found in PEEK group. As there for due to a 4 GPa modulus of elasticity of PEEK, it is as elastic as bone and can reduce stresses transferred to the abutment teeth rather than Co-Cr which have high modulus of elasticity is about 210 GPa compared to alveolar bone.*
Conclusion: *The lost wax fabricated removable partial denture, constructed from new PEEK material (Bio dent) showed more favorable effect on the abutment teeth in lower Kennedy Class II distal extension bases than the conventional metallic dentures as bone height changes. However, there were inevitable changes associated with RPD insertion in terms of pocket depth, clinical attachment level, tooth mobility as well.*
Key Words*: PEEK; CoCr; Lower RPD Kennedy class II; Periotest; Pocket depth; Clinical attachment level; Digital periapical x-ray.*

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I. Introduction

Our teeth have such an important role to play in our lives. They help us in chewing and digesting food, they help us in talking and speaking clearly and they also give our face its shape. Tooth loss may occur due to several reasons such as caries, periodontal disease, trauma and systemic disease. This results in disruption of daily-living activities such as chewing, emotional problems, Loss of self-confidence due to bad esthetics.

The use of a removable partial denture (RPD) in clinical practice as in Kennedy class II remains a viable and probable treatment modality.[1-3]The use of other options to RPD such as implants may not always be practical for a number of reasons and the benefits of RPDs are well documented.[3]

Tooth-tissue supported RPDs (as in Kennedy Class II) require a framework material to engage with abutment teeth for support, direct retention and indirect retention. Numerous materials have been introduced in dentistry for partial dentures. These include wood, ivory, porcelain, hard gold alloys, vulcanite thermoplastic

polymer and the PMMA. The PMMA becomes the most frequently used materials for denture bases as an alternative to hard gold alloys .[4]

Other choices for framework materials include Cobalt Chromium (Co-Cr) which have high strength, heat-resistant, non-magnetic, favorable resistance to wear, corrosion and tarnish. They have excellent biocompatibility, but have high modulus of elasticity compared to alveolar bone, heavy weight, unpleasant metal esthetic, allergy and bad taste.

Recently poly-ether-ether-ketone (PEEK) became more popular in dentistry, starting with implantology, fixed and removable prosthesis including maxillofacial obturators. PEEK is one of the critical biomaterials that have potential to be used instead of metals inside the human body.[5, 6] As it could be used in the food processing industry as a coating for corrosion resistance .[7] However, Fitch et al. (2010) pointed out; it has had extensive use for biomedical purposes. It is considered as an ingenious thermoplastic material for use in reconstructive shock and spinal implants; in addition it shows extreme biocompatible stability when sterilized by steam, ethylene oxide or other chemicals.[8]

Tannous et al,[9] stated that denture clasps made of PEEK may have lower retentive forces compared to Co-Cr clasps.[9] The application of PEEK in a removable dental prosthesis was reported that successfully used PEEK material as an alternative material to metals and acrylic resins.[10, 11] It is a high performance polymer, which presents high biocompatibility, good mechanical properties, high temperature resistance, and chemical stability.[12, 13, 14] Due to a 4 GPa modulus of elasticity, it is as elastic as bone and can reduce stresses transferred to the abutment teeth. Furthermore, the white color of BioHPP frameworks provides a different esthetic approach than the conventional metal framework display does. Additional advantages of this polymer material are elimination of allergic reactions and metallic taste, high polishing qualities, low plaque affinity, and good wear resistance.[15]

PEEK can be improved by adding different materials that improves its mechanical properties. For example, when strengthened with carbon its modulus of elasticity is increased up to 4 GPa and becomes similar to that of cortical bone and dentine. This makes it less stress shielding. Furthermore, PEEK improved with 20% ceramic fillers (BioHPP) has been introduced to dental applications and provide us with many satisfactory properties such as: excellent biocompatibility, good mechanical and chemical properties and high temperature resistance.[16]

BioHPP material can be used for patients allergic to metals, who dislike the metallic taste, the weight and the unpleasant metal display of the denture framework and retentive clasps. BioHPP frameworks can be fabricated either via CAD/CAM manufacturing or via the conventional lost wax technique.

The abutment tooth was evaluated clinically and radiographically. Clinically by using periodontal probe in measuring pocket depth and clinical attachment level, and the periotest was used to measure tooth mobility. The Periotest is designed to precisely calculate the tooth mobility from the state of the rebound of the tapping head. The tapping head in the handpiece beats the surface of the tooth at a rate of four times per second. The duration of the contact of the tapping head on the tooth surface is measured by the instrument that calculates the Periotest value to indicate tooth mobility.

Radiographically by using digital periapical x-ray. Digital radiographs expose patients to less radiation on a per-radiograph basis. Additionally, digital radiographs are in general quicker to take and view than radiographs using film.[17] Computerized image enhancement of digital radiographs allows the viewer to change brightness and contrast and to invert, color, measure, or magnify the image.[18, 19] The ability to view the image in different formats may aid in diagnosis and in some cases, compensate for otherwise less-than-ideal radiographs, making them usable as such, image enhancement may contribute to a reduced absolute number of retakes .[20] This technology adheres to the ALARA (As Low As Reasonably Achievable) principle, which promotes radiation safety.[21]

The purpose of this study was to compare between Cobalt chrome and poly-ether-ether-ketone material in the fabrication of a mandibular Removable Partial Denture Kennedy Class II clinically and radiographically.

II. Material And Methods

This prospective comparative study was carried out on patients of Department of Prosthodontic, Faculty of Dentistry, Tanta University.

Study Design: This study was conducted as a clinical trial.

Study Location: This clinical study was carried out at Prosthodontic Department, Faculty of Dentistry, Tanta University, from November 2018 to February 2020.

Study Duration: November 2018 to February 2020.

Sample size: 14 patients.

Subjects & selection method: Fourteen patients (both male and females) having mandibular Kennedy Class II RPD (missing from 6 to 8 at one side) were selected from those attending to the Outpatient Clinic of The

Prosthodontics Department, Faculty of Dentistry, Tanta University. These patients were divided randomly by coin flipping into two groups, each group consists of seven patients:

- Group A: Seven patients received cobalt chrome (CO-CR) removable partial denture using conventional method.
- Group B: Seven patients received RPD fabricated from poly-ether-ether-keton (PEEK) (BioHPP) using lost wax technique.

Inclusion criteria:

1.Patients having lower second premolar as abutment.
2.Patients age ranging from 35 to 55 years old.
3.They have good oral hygiene.
4.They have acceptable interarch space.
5. The abutments teeth are periodontally healthy.
6. Angle Class I.

Exclusion criteria:

1.Systemic disorders.
2.Oral disease.
3.Occlusal discrepancy.
4.Abnormal Oral habits as bruxism and clenching.
5.Smoking.
6.TMJ problems.

Procedure methodology

The purpose of the present study was explained to the patients and informed consent document was signed in the research according to the guidelines on human research adopted by the Research Ethics Committee at Faculty of Dentistry, Tanta University.

A-Dental investigations:

1.Clinical examination:
a-Introduction of the patient and know the chief complain.
b- Diagnosis and writing a case chart with preparation and motivation the patient to the treatment.
c- Clinical examination for all teeth and supporting tissue.
2.Radiographic examination for the abutment tooth was performed using digital periapical radiograph,[1] to show bone loss related to abutment teeth.
3-Selecting a rigid perforated metal stock tray with approtiate size and taking primary impression with alginate material and pouring a study cast for both arches.
4-Study casts for treatment planning and suggestion of the prognosis after deciding to make removable partial denture.

B- Cast preparation:

1. Surveying the cast by dental surveyor[2] to determine path of insertion and removal of the framework and to determine the undercuts present.
2. Mounting the diagnostic cast on the articulator with wax bite for determining inter arch space, over eruption of teeth and for selection the type of minor connector on the saddle area.
3. Drawing the removable partial denture design on the surveyed study cast which consists of:

- Clasp design: RPI: mesial rest, distolingual guide plate, I-bar on abutment.
- Cross arch stabilization: Double Aker clasps on second premolar and first molar on dentulous side.
- Major connector: lingual plate connects all components of RPD.
- Minor connector: The small struts protruding from the lingual plate and connect components of direct and indirect retainer.
- Indirect retainer: Cingulum rest seat on the canine in the other side.
- Saddle area: A ladder type minor connector used as a saddle framework that allows the pink base material to connect to PEEK or to the metal framework of the RPD.

4. Fabrication of a perforated acrylic tray on the study cast.

[1] New life radiology S.R.L. Italy.
[2] Dentsply Ney Dental Surveyor, USA.

C-Patient preparation:

1.Mouth preparation of teeth (reshaping, occlusal rest seat, guiding planes and restoration if needed).
2.Making the final impression with the special tray by alginate[3] impression material.

D-Denture consruction:

• Laboratory work:

1. Pouring the impression and resurveying the master cast and block out the undesirable undercut using wax[4].
2. Duplication the master cast by agar-agar[5] to produce a refractory cast from investment material.
3. Form the wax pattern on the duplicated cast according to the established design, wax and plastic pattern (ready-made)[6] were used to form the pattern of the removable partial denture framework.
4. Spruing, investing and burning out of the wax framework.
5. Melting the metal or PEEK by the centrifuge, and casting it to occupy the space left from the wax elimination according to the groups: -

• **Group A:** (CO-CR)[7] metal was used. Heat was applied to melt the metal, and then the molten metal was injected into the mold cavity then Cooling of the ring and opening of the mold to obtain the metal framework.

• **Group B:** PEEK granules or pellets[8] were used. They were placed into a hopper in the machine and automatically introduced into a heated screw. The molten PEEK flows into a heated mold once the heated screw has melted and pressurizes the molten polymer. Then, the molded sample was automatically driven out from the mold after PEEK component solidification.

6. Finishing and polishing of the framework.
7. Checking of the framework on the master cast.

E- Clinical work:

1. Checking the framework inside the patient mouth.
2. Adding self-cure acrylic resin[9] to saddle area with 1 mm wax relief between the acrylic resin and ridge to allow space for ZOE impression material.
3. 10.Altered cast impression technique was made by adding green compound [10]to the periphery of the self-cure for border modeling then making impression to saddle area with zinc oxide-eugenol (ZOE)[11].
4. The master cast was modified for altered cast procedures by drawing a line on the saddle area which represent a broken line, then sawing the cast at the saddle area by a stone saw.
5. Framework impression assembly was properly seated and sealed on modified master cast, then the assembly was inverted for boxing procedure. Then mixing the stone and pouring the cast.
6. Registration of centric jaw relation from the patient and teeth selection.
7. Mounting the casts on the articulator[12], selection of teeth size13, shape and shade of teeth according to patient natural teeth, then setting of teeth and waxing.
8. Try in stage in the patient mouth.
9. Flasking, wax elimination, packing and curing.
10. Deflasking, finishing and polishing.
11. Insertion in the patient mouth and give post insertion instructions.
12. Follow up for both groups was evaluated at 3, 6 and 9 months.

Methods of evaluation:

I-probing pocket depth:(22)

The distance from the free gingival margin to the bottom of the pocket was recorded at six sites for each examined tooth by a periodontal probe. The probe was inserted in line with long axis of the tooth and walked

[3] Tropicalgin alginate impression material, Italy.
[4] Thowax, Germany.
[5] Zetalabor, gingi fast, USA.
[6] Cervikalwachs, Germany.
[7] Magnum H75, Italy.
[8] BioHPP, Bredent GmbH, Senden, Germany.
[9] Vertex, self cure acrylic resin, Spain.
[10] Perfectin, modeling compound, Argentha.
[11] White, impression paste, England.
[12] Semiadjustable articulator, USA.
[13] Acry Rock, Italy.

circumferentially around each surface of the abutment tooth, measurements were recorded and the average was obtained by summing the scores for the six sites and dividing it by six.

II-Clinical attachment level (CAL): [22, 23]
The distance from the cement-enamel junction to the bottom of the pocket. It was measured in the same way as probing depth.
The cemento-enamal junction (CEJ) is the point of intersection between the outer edge of the enamel of the crown and the outer edge of cementum of the root.
The alveolar crest for each tooth surface was the most coronal point of bone adjacent to the tooth surface which was reached by periodontal probe probe.[24]

III-Tooth mobility:
The functional test of the periotest was done by measuring the supplied test sleeve as the following:
1- Remove the Periotest M from the charger and fit the test sleeve onto the tip of the probe.
2- Press the start button to switch on the unit. After 2 seconds a melody plays and the unit is ready to measure.
3- Hold the Periotest M horizontally and press the start button again. The measuring process starts.
4-After the measuring cycle (approx. 4 seconds, 16 impulses) is finished, the short melody plays again and the reading is indicated on the display.
5-The reading should match the value indicated on the test sleeve. A deviation of +/- 2.0 Periotest values is acceptable.
6-In case of a higher deviation, or in case no reading at all is indicated, the Periotest M does not measure properly.
7-Remove the test sleeve from the tip of the probe and plug it onto the holder on the rear side of the charger.
8-Patient set in upright position.
9-The teeth of the maxilla and the mandible must not have contact to each other. However, the patient should open his mouth only a little bit and not too wide to enable an easy access to the molar area.
10-Periotest was positioned at the center of tooth.
11-The periotest device is placed in a horizontal position 0.6–2 mm away from the tooth surface.
12-During measurement, the device delivers 16 impacts in 4 s to the object. The duration of contact of the tapping head on the tooth surface is measured by the instrument that calculates the PTV, indicating tooth mobility.
13- The Periotest scale ranges from -8.0 to +50.0. The smaller the Periotest value, the higher the stability / damping degree of the tooth.

IV- Radiographic evaluation:
Direct digital radiograph using Best-X-DC* x- ray[14] was taken for each patient.
1-Lead apron was used to protect the patient from the scattered radiation.
2-The patient is positioned with the head supported and with the occlusal plane horizontal.
3-A beam aiming device was used which consists of film holder, bite block, locator ring and indicator ring.
4-The intraoral wireless sensor was adapted in the film holder opposite to the lingual surface of lower premolars.
5-The patient is requested to bite gently on the bite block, to stabilize the holder in position.
6-The locator ring was moved down the indicator rod until it was just in contact with the patient's face. This ensures the correct focal spot to film distance (fsd) to take the x-ray every time from the same position.
7-The cone of the x-ray was aligned with the locator ring. This automatically sets the vertical and horizontal angles and centers the X-ray beam on the image receptor.
8-The exposure was made. Then the image appeared on the computer after scanning of the PSP plate by laser beam of the RVG device. Then values calculated for bone loss according to the following equation:
The distance is from cementoenamel junction to most coronal aspect of interproximal alveolar bone divided by the length of the root.

[14] New life radiology S.R.L Italy.

Fig 1: Shows alginate primary impression

Fig 2: shows survaying of the cast on the survayor

Fig 3: Shows design of the framework on the study cast

Fig 4: Shows the wax pattern design

Fig 5: Shows the metal framework try-in

Fig 6: Shows the PEEK framework try-in in the patient mouth

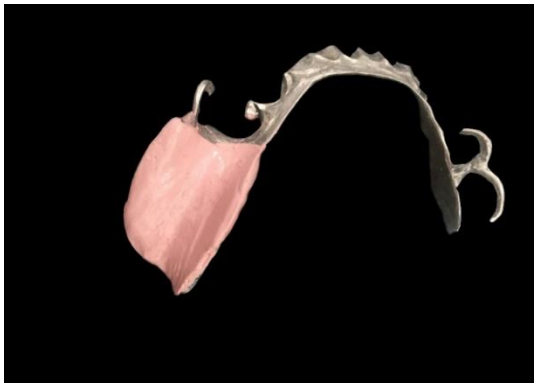

Fig 7: Shows altered cast impression for metal framework

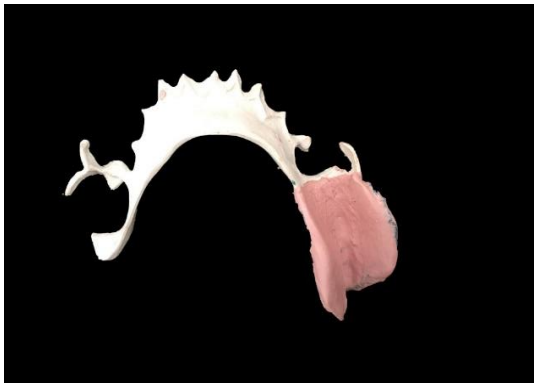

Fig 8: Shows altered cast impression for PEEK framework

Fig 9: Shows the metal RPD insertion

Fig 10: Shows the PEEK RPD insertion

Fig 11: The periodontal probe measuring the pocket depth

Fig 12: Shows the periotest reading in the patient mouth

Fig 13: Shows the use of the beam aiming device during x-ray exposure

Statistical analysis

Numerical variables are expressed by descriptive statistics as mean, standard deviation and range. Repeated measure ANOVA and post hock test (tukey-test) were used to compare quantitative data within group. Dependent t-test was used to compare material within different durations. P-value <0.05(*) was considered significant difference & P-value <0.001(**) was considered highly significant difference. Statistical analyses were performed using Statistical Package for Social Sciences (SPSS version 25).

III. Result

The results of the present study consisted of two parts: a clinical part and radiographic part. They evaluated the effect of different denture base materials on the abutment teeth as evaluated clinically by pocket depth (PD), clinical attachment level (CAL), and periotest and radiographically by using digital periapical x-ray.

All patients were followed up after insertion of denture in the mouth at baseline, 3, 6 and 9 months.

The baseline measurements for both groups showed no statistically significant differences among the treatment modalities for any measured clinical and radiographic parameters as evident by their mean baseline values (P> 0.05).

A-Clinical evaluation:

1-Pocket depth:

Table no.1 and diagram no 1, show a comparison of pocket depth between metal and PEEK RPD at baseline, 3, 6 and 9 months, using ANOVA test. The P-value in metal group was less than 0.05; therefore, there is a significant difference between durations in metal. The P-value in PEEK group was 0.621; therefore, there is no significant difference between durations.

In table no.2, Tuckey test was used for more specific evaluation between the metal values. There is a significant difference in baseline with 6 months, baseline with 9 months and also between 3 months with 9 months. But there is no significant difference between baseline with 3 months, 3 months with 6 months and between 6 months with 9 months.

Table no 1: Shows measurements of the pocket depth of metal and PEEK groups.

Duration	Metal	PEEK
Baseline	2.25±0.42	2.06±0.83
After 3 months	2.33±0.39	1.79±0.70
After 6 months	2.86±0.41	1.89±0.73
After 9 months	3.13±0.36	1.98±0.76
F	14.259	0.493
p-value	0.004*	0.621

Table no 2: shows the Tuckey test of PD for the metal group.

Metal	Baseline	After 3 months	After 6 months
Baseline	-------	-------	-------
After 3 months	0.542	-------	-------
After 6 months	0.012*	0.066	-------
After 9 months	0.000**	0.000**	0.253

There is a significant at P-value< 0.05 (*), and highly significant at P-value< 0.001(**).

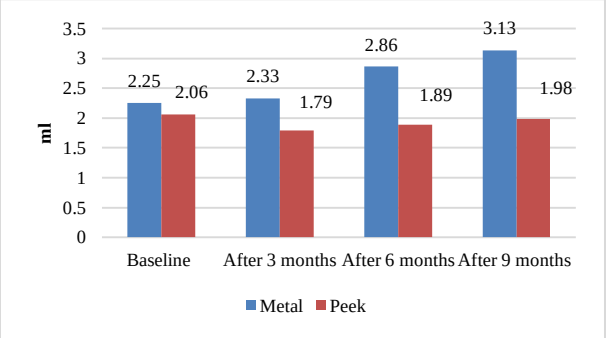

Diagram no 1: Shows pocket depth measurements at baseline, 3, 6 and 9 months of metallic and PEEK RPD.

2-Clinical attachment level (CAL):

Table no 3 and diagram no 2, show a comparison of clinical attachment level between metal and PEEK RPD at baseline, 3, 6 and 9 months, using T-test. The P-value in metal group was less than 0.05; therefore, there is a significant difference between durations in metal. The P-value in PEEK group was 0.330; therefore, there is significant difference between durations.

In table no 4 Tuckey test was used for more specific evaluation between the metal values. There is a significant difference in baseline with 6 months, baseline with 9 months and also between 3 months with 9 months. But there is no significant difference between baseline with 3 months, 3 months with 6 months and between 6 months with 9 months.

Table no 3: Shows measurements of the clinical attachment level of metal and PEEK groups.

Durations	Metal	Peek	t	p-value
Baseline	1.33±0.41	1.26±0.77	0.288	0.776
After 3 months	1.52±0.41	1.35±0.78	0.756	0.456
After 6 months	1.83±0.46	1.29±0.76	2.268	0.032*
After 9 months	2.38±0.45	1.29±0.76	4.639	0.000**

Table no 4: Shows the Tuckey test of CAL for metal group.

Metal	Baseline	After 3 months	After 6 months
Baseline	---------	---------	---------
After 3 months	0.235	---------	---------
After 6 months	0.001*	0.046*	---------
After 9 months	0.000**	0.000**	0.006*

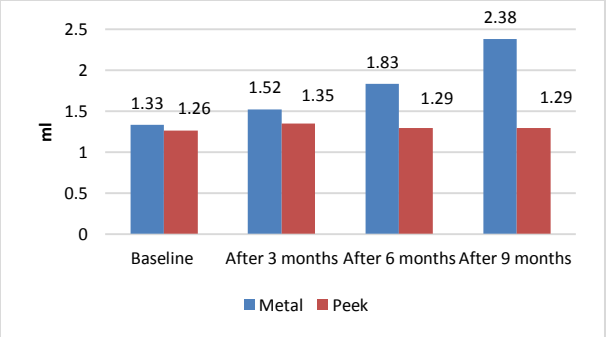

Diagram no 2: Shows clinical attachment level measurements at baseline, 3, 6 and 9 months of metallic and PEEK RPD.

3-Periotest:

Table no 5 and diagram no 3, show a comparison of periotest between metal and PEEK RPD at baseline, 3, 6, 9 months. Using T-test, the P-values in metal group was less than 0.05; therefore there is a significant difference between durations of metal. The P-value in PEEK group was less than 0.05; therefore there is a significant difference between durations of PEEK group.

In table no 6, Tuckey test was used. There is no significant difference between all durations except baseline with 9 months and 3 months with 6 months in metal group. In PEEK group show there is no significant

difference between baseline with 3 months and 6 months with 9 months. There is significant difference between baseline with 6 months, baseline with 9 months, 3 months with 6 months and 3 months with 9 months.

Table no 5: Shows measurements of the periotest results of metal and PEEK groups.

Duration	Metal	PEEK
Baseline	4.23±2.12	2.64±0.29
After 3 months	4.77±2.33	2.89±0.39
After 6 months	5.29±2.50	3.19±0.42
After 9 months	6.58±3.08	3.28±0.38
F	5.266	11.156
p-value	0.028*	0.001*

Table no 6: shows the Tuckey test of periotest for metal and PEEK groups.

Metal	Baseline	After 3 months	After 6 months
Baseline	-------	-------	-------
After 3 months	0.389	-------	-------
After 6 months	0.143	0.013*	-------
After 9 months	0.027*	0.056	0.119
PEEK			
Baseline	-------	-------	-------
After 3 months	0.101	-------	-------
After 6 months	0.009*	0.003*	-------
After 9 months	0.001*	0.022*	0.474

There is a significant at P-value< 0.05 (*), and highly significant at P-value< 0.001(**).

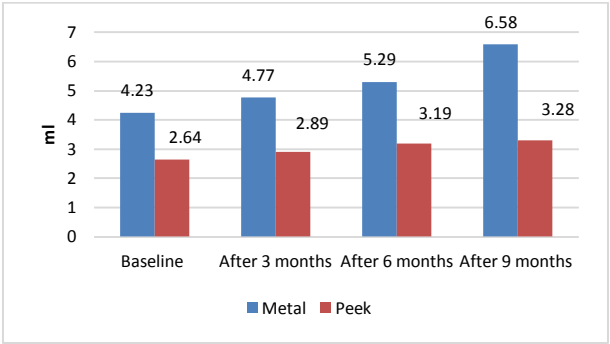

Diagram no 3: Shows periotest measurements at baseline, 3, 6 and 9 months of metallic and PEEK RPD.

B-Radiographic evaluation:

Table no 7 and diagram no 4, show a comparison of x-ray between metal and PEEK RPD at baseline, 3, 6, 9 months. Using T-test, the P-values in metal group was less than 0.001; therefore there is a high significant difference between durations of metal. The P-value in PEEK group was less than 0.05; therefore there is a significant difference between durations of PEEK group.

In table no 8, Tuckey test was used to show there is a significant difference between durations in metal. All durations were significant with each other except baseline with 3 months.

There is a significant difference between durations in PEEK. All durations were significant with each other except baseline with 3 months.

Table no 7: Shows measurements of the x-ray results of metal and PEEK groups.

Duration	Metal	PEEK
Baseline	1.63±1.14	1.48±0.10
After 3 months	1.72±1.01	1.54±0.12
After 6 months	1.88±1.07	1.52±0.13
After 9 months	2.24±1.09	1.74±0.20
F	100.899	10.326
p-value	0.000**	0.001*

Table no 8: Shows the Tuckey test of X-ray for metal and PEEK groups.

Metal	Baseline	After 3 months	After 6 months
Baseline	-------	-------	-------
After 3 months	0.230	-------	-------
After 6 months	0.001*	0.003*	-------
After 9 months	0.000**	0.000**	0.000**
PEEK			
Baseline	-------	-------	-------
After 3 months	0.172	-------	-------
After 6 months	0.337	0.746	-------
After 9 months	0.001*	0.020*	0.002*

There is a significant at P-value< 0.05 (*), and highly significant at P-value< 0.001(**).

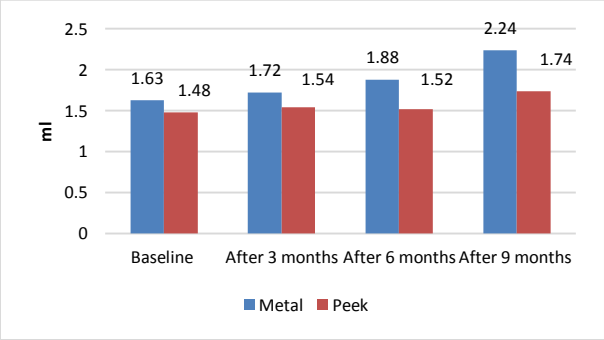

Diagram no 4: Shows X-ray measurements at baseline, 3, 6 and 9 months of metallic and PEEK RP

IV. Discussion

The choice of the material for the construction of RPDs should be based on clinical examination, patient's demands, and scientific evidence.

The RPDs which are made of materials such as PEEK have lighter in weight, more esthetic due to its white color, biocompatible, non-allergic, high strength, rigid material, with flexibility comparable to bone, high polishing, low absorption properties, low plaque affinity and good wear resistance. BioHPP permits the fabrication of metal- free clasps and occlusal rests, providing occlusal stability and metal -free esthetics.[25]

Therefor in this study a comparison between PEEK and Co-Cr framework was done.

Discussion of materials and methods:

In this study Kennedy Class II patients were selected due to the greater rotation of distal extension in RPD around the supporting rest under occlusal loading leading to creation of distal torque on the abutment. Because of the difference in support between the abutment teeth and the residual ridges. Distal extension RPDs are represented as one of the most critical status for achieving successful long- term treatment outcome and preservation of the remaining natural teeth and their supporting structures.[26, 27]

The lingual plate was selected rather than lingual bar to be used in all patients who have high lingual frenum or have a too limited space to lingual bar (where a clinical measurement from the free gingival margins to the slightly elevated floor of the mouth is less than 8 mm, a lingual plate is indicated rather than the lingual bar).[28]

An occlusal rest placed on the mesial or anterior part of the most distal abutment tooth provides the forces to be with long axis of the abutment. This providing a mesial rotation point will tend to tip the abutment tooth anteriorly where it will be reinforced and assisted by other teeth.[29]

The I bar retentive clasp, when placed at the point of greatest circumference of the tooth and used in conjunction with a mesio-occlusal rest or anterior rotation point, will exert no adverse or torquing force on the abutment tooth.[29]

The surveyor was used to identify and mark the position of maximum convexity (survey line) separating non-undercut from undercut areas to measure the undercut on the abutment tooth. The PEEK clasps with an undercut of 0.5 mm could provide adequate retention for clinical use. [9] While undercut of 0.2 mm was used with Co-Cr clasps. The surveyor also used to determine the path of insertion and removal of the prosthesis by providing guiding planes on the abutment teeth to improve the stability of the prosthesis.[30]

The altered-cast technique was used for remarkable stability in the denture base region of distal extension removable partial dentures, for positive occlusion which will be maintained for long periods of time,

to reduce stress on abutment teeth from unfavorable forces and to reduce numbers of post insertion adjustments.[31]

The lost wax technique has been chosen for this research because it can be well manipulated, precisely shaped, and completely eliminated from the mold by heating. [32]Also, the low roughness values and precise tolerances that can be achieved. Additionally, great freedom exists in both product design and material choice. Also, it is more economic than CAD-CAM technique.

The periodontal probe is the main instrument that was used to assess the status of the periodontium, either for screening purposes or to evaluate periodontal changes throughout the treatment process. They are highly sensitive and specific diagnostic tools, measuring the CAL and PD which are essential part of periodontal examination.[33]

The Periotest has the ability to recognize fine gradations of clinical mobility combined with a demonstrated capacity to generate highly reproducible results. The measurements are sensitive and the readings are automated. Andresen et al,[34] suggested that the Periotest measurement is more sensitive than traditional methods at detecting periodontal damage and unfavorable sequelae.

Minimal amounts of radiation exposed to the patient was made by chosen the digital periapical radiographs as a diagnostic tool. As it decrease the harmful effects of cumulative exposure to radiation compared to traditional periapical x-ray.[18, 19] . Computerized image enhancement of digital radiographs allows the viewer to change brightness and contrast and to invert, color, measure, or magnify the image. The ability to view the image in different formats may aid in diagnosis and, in some cases, compensate for otherwise less-than-ideal radiographs, making them usable as such, image enhancement may contribute to a reduced absolute number of retakes.[35]

Beam aiming device was used to guide the X-ray beam, thereby helping to increase the accuracy of dental radiography and taking the x ray every time in the same position.[35]

In the present study the percentage of alveolar bone loss as described by Hausmann et al,[24] was measured from digital periapical radiographs using the SIDEXIS XG program accompany the Best-X-DC digital periapical machine. This is in agreement with Parks 2008 [36] who stated that loss of bone height should be evaluated using an automated instrument to diagnose periodontal lesions and assess the treatment success.

Discussion of the result:

I-Pocket depth and clinical attachment level:

The result of this research shows that there was a significant difference in all durations of metal and no significant difference between durations in PEEK in pocket depth and clinical attachment level. This is due to the high biocompatibility of PEEK with the tissue as it contain 20% ceramic fillers which is a high performance polymer, which provide high smooth surface and high polishing qualities which decrease plaque and food accumulation which are considered the main reasons for increasing the PD and CAL. [37]

There was statistically significant difference between the two groups after six and nine months of follow up regarding the PD and CAL with statistically significant difference after nine months of follow up for the CAL. Group B showed lower mean values than the group A. This finding could be attributed to the biocompatibility that ensure accurate adaptation and fitness of the denture framework components.[37] The results of this research agree with those of Taha E R.[38]

II- Periotest:

For assessment of tooth mobility, the periotest was used providing an effective system for evaluating tooth mobility. There was a significant difference between baseline with 9 months and between 3 months with 6 months in metal. This due to the high weight of Co-Cr RPD compared to PEEK RPD. The BioHPP has a low specific weight that permits the fabrication of lighter prostheses providing high patient satisfaction and comfort during function which lead to reduce the forces transmitted to abutment teeth and decrease the mobility of teeth.[37]

According to Zlataric et al, proper design of an RPD is important for the maintenance of periodontal health. Compared to Co-Cr RPDs, BioHPP RDPs provide a hygienic design that simplifies oral hygiene. [39]

III-Digital periapical radiograph:

The results of this research show that there was a non-significant difference between baseline and 3 months in metal and PEEK groups. As Early periodontal lesions are not detected in radiographs. The amount of periodontal destruction in more advanced disease is generally underestimated as noted by (Goldman et al,[40] Wengraf).[41]

Bone height loss around the abutment teeth was reported after six months of denture insertion for the two studied groups which may be explained on the bases that gingival parameters increase after six months of wearing dentures as noted by Tatjana et al.[42] Other investigators were agree with our results, showing correlation between the interdental alveolar bone loss and gingival parameters following partial denture insertion.[43, 44]

This finding could be attributed also to the horizontal and lateral stress on the abutment teeth in the distal extension bases which may cause breakdown of periodontal tissue and bone loss.[26, 27]

The bone loss was greater in Co-Cr more than that was found in PEEK group. As there for due to a 4 GPa modulus of elasticity of PEEK,[37] it is as elastic as bone and can reduce stresses transferred to the abutment teeth rather than Co-Cr which have high modulus of elasticity is about 210 GPa compared to alveolar bone.[45]

V. Conclusion

The lost wax fabricated removable partial denture, constructed from new PEEK material (Bio dent) showed more favorable effect on the abutment teeth in lower Kennedy Class II distal extension bases than the conventional metallic dentures in terms of pocket depth, clinical attachment level, tooth mobility as well as bone height changes. However, there were inevitable changes associated with RPD insertion.

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