

## EFFECT OF DIFFERENT PARTIAL DENTURE DESIGNS IN MANDIBULAR DISTAL EXTENSION CASES ON BACTERIAL GROWTH (A RANDOMIZED CLINICAL TRIAL)

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### ABSTRACT

**Objective:** The purpose of the present study was to evaluate the microbiological effect of different designs of direct retainers of removable partial dentures (attachments, and clasp retainers “metal and PEEK”) in mandibular distal extensions partial dentures.

**Materials and methods:** 30 patients having Kennedy class I or class II mandibular partially edentulous ridges with fully dentate maxillary arch were divided into three equal groups. *Group A* received a lower partial denture retained with attachments (OT attachment), *Group B* received a partial retained with an RPI metal clasp, and *Group C* received a lower partial denture retained with a thermoplastic material (PEEK). The adhesion of bacteria of the three groups was measured by using (a brain heart infusion agar plate): at the time of denture insertion, after two weeks, after four weeks, six weeks, and 8 weeks of denture insertion. The collected data were tabulated and statistically analyzed.

**Results:** Within the group that received partial denture retained with attachments, the bacterial growth has increased as the follow-up period measured, more than that group received partial denture retained with PEEK retainer and more than that retained with cast clasp direct retainer. During the follow-up period, there was a statistically significant difference between the three groups.

**Conclusion:** Attachments retained removable partial denture-induced higher bacterial count than retained with PEEK (Polyetheretherketone) retainer and metal clasp retainer.

**KEYWORDS:** Distal extension saddle, extra-coronal attachments, PEEK, bacterial accumulation.

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## INTRODUCTION

Removable partial denture restoring unilateral and/or bilateral distal extension cases has always been a challenge to prosthodontics, a cost-effective and reversible treatment method for partially edentulous patients at any age. The main problem lies in how to reach a successful RPD to provide adequate support, retention, and stability, without jeopardizing the teeth and integrity of the remaining oral structure.<sup>(1)</sup>

The important criteria of a successful partial denture are to function well, comfort, be easy to clean, and prevent adhesion of micro-organisms as much as possible on its surface and/or on the oral mucosa that leads to undesirable effects such as unpleasant odor, taste, and unesthetic appearance.<sup>(2)</sup>

Direct retainers are an important component of removable partial dentures, where cast clasp retainer is the most used. Despite the problems that are associated with it, for example, increase gingivitis, periodontitis, and abutment mobility. Besides inferior esthetics in terms of metal display especially in the anterior esthetic zone<sup>(3)</sup>. Thermoplastic material as PEEK (Polyetheretherketone) have been used and become a potential pathogenic factor for oral mucosa being in contact with this material<sup>(4)</sup>, it has been introduced to various dental applications such as dental implants, implant abutment, fixed crowns, fixed bridges and removable partial dentures<sup>(5-6)</sup>. The use of Removable partial denture made of thermoplastic resin (PEEK) is now rapidly gaining popularity among general dentists and is considered to be superior to conventional metal-clasp retained RPDs with metal clasps in terms of both esthetics and comfort as the rigidity of the metallic framework distribute the forces equally and thermoplastic clasps enhance the esthetic so these type of RPD made a combination of esthetic and mechanical point of view.

Extra-coronal attachments may be utilized successfully in unilateral and/or bilateral distal extension cases, providing superior esthetics and

retention. Moreover, advantageous distribution of favorable stresses to the abutment teeth<sup>(7)</sup>. The complicated design of the extra-coronal attachments may require specific oral hygiene measures and the motivation of the patient.<sup>(8)</sup>

## MATERIAL AND METHODS

Thirty patients were selected from the out-patient clinic of the Prosthodontic Department, Faculty of Dentistry, Cairo University.

Patients were divided into three groups randomly by using a special website concerned with the randomization process called research randomizer ([www.randomizer.org/](http://www.randomizer.org/)), The patients were randomly assigned to either one of the three groups *Group A* ( 10 patients received mandibular partial dentures retained with cast clasp retainer), *Group B* (10 patients received mandibular partial dentures retained with injectable polyetheretherketone (PEEK) (GMbH&Co.KG.Germany) reinforced by metal framework), and *Group C* (10 patients received mandibular partial dentures retained with attachments OT attachment).

All patients were selected according to the following criteria:

### Inclusion criteria:

- 1- All patients were having Kennedy class I or II mandibular partially edentulous ridges with fully dentate maxillary arch.
- 2- All patients have skeletal maxilla- mandibular relationship with sufficient interarch distance.
- 3- Patients with an age range (40-55 years).
- 4- All patients were with good oral hygiene and low caries index.
- 5- The remaining teeth have good periodontal conditions with no signs of attrition or gingival recession and are free from any temporomandibular joint disorder.

The study was designed to be a parallel randomized controlled trial. In terms of internal validity, randomized clinical trials represent the most scientifically rough study design, when properly performed, as they are best able to control partiality and assist as a gold standard of study designs for evaluating treatment efficacy and are widely considered as the highest level of confirmatory scientific evidence.

For all groups preliminary impressions were made for the patient's maxillary and mandibular arches by using irreversible hydrocolloid (alginate) (Cavex CA37 Alginate impression material, Holland BV). Impressions were disinfected, then poured an improved dental stone (Elite® rock dental stone, Zermack, Italy). Primary surveying was done on the diagnostic casts, and then a face-bow record was used to mount the maxillary cast on a semi-adjustable articulator (A7 plus, Bio-Art Dental Products, São Carlos, SP, Brazil.) to check for any teeth interferences and to assess the antero-posterior jaw relation. This was important to evaluate interarch distance to accommodate the future prosthesis.

Panoramic and periapical radiographs were performed as a complete mouth survey to evaluate the bone index areas and crown root ratio. The selected patients were informed about the participation in scheduled follow-up for 2 months after receiving the removable partial denture by written informed consent and signed by each patient as it is one of the most important facets of bioethics to make sure that a patient understands the risks and benefits of any medical procedure. (Ilfeld 2006) stated that - Requiring informed consent protects many patients from being forced to participate in medical studies without understanding the risks involved.

For *Groups A and B* received removable partial dentures retained with metal clasp, mouth preparation was made including guidelines preparation and rest seat preparation. The

mandibular final impression was taken using medium-bodied elastomeric impression material (Aquasil Monophase, DENTSPLY CAULK, USA) mixed according to the manufacturer's instructions. Impression was boxed and poured, in extra hard dental stone (Elite® rock dental stone, Zermack, Italy). The master cast was modified by drawing the design which is a lingual bar and/or sublingual bar as a major connector, RPI was drawn on the last abutment tooth of the edentulous side ( mesio-occlusal rest, proximal plate, I -bar retentive arm), indirect retainer in the form of cingulum rest on the canine in the intact side, and a meshwork denture base. and then duplicated into a refractory cast by using silicon (Technosil, Bredent, Germany) to fabricate the metal framework. (**Figure 1**)



Fig. (1): Metal framework of mandibular partial denture

For the Polyetheretherketone PEEK clasp, it was preheated at 400 Co for 20 minutes by using the injection molding unit (Thermoflex 400) then Heated softened PEEK was injected into the mold by pressure 950mega pascal and velocity 6 bars in 240 seconds. After curing, the dentures were deflasked then; they were ready for finishing and polishing using thermal resin finishing burs at low speed, pumice, and finally buffing with swans down mop was done to add a very high luster.

For Group C received attachments retained removable partial denture, The lower first and

second premolars on each side were prepared to receive two connected full Porcelain Fused to Metal (PFM) crowns. A putty impression (Zeta plus, Zermack, Italy) was made and a dual impression was carried out in a conventional manner. The prepared abutments were protected by ready-made temporary crowns which were cemented using temporary cement (Temp-Bond™ Temporary Dental Cement | Kerr Dental, Germany). The impression was then washed, inspected, and poured into an extra-hard dental stone (Type III Dental stone, Lascod SPA, Sestofino, Italy). Wax patterns of both crowns were built-up and the completed wax pattern of the crown-attachment assembly (Rhein OT unilateral) was sprued, invested, and cast into a nickel-chromium (Nickel-Chromium metal framework, Vita, Switzerland) metal. (Figure 2)

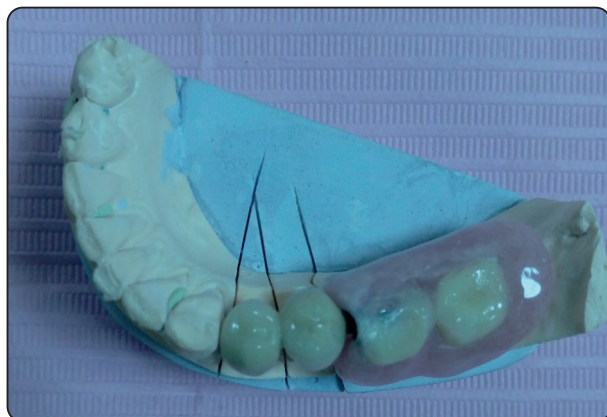


Fig. (2): Removable partial denture retained with OT attachment

The crown-attachment assembly was tried in the patient mouth and proper positioning of the attachment was checked in relation to the ridge.

### Microbiological Evaluation.

After the denture was delivered, the bacterial growth was recorded immediately after insertion, second week, the fourth week, the sixth week, and eighth week, following insertion using (the brain heart infusion agar plate).

### Swab collection

A swab was collected from an area of (1cm x 1cm) dimension in the internal surface (fitting surfaces) of the mandibular partial denture covering the crest of the ridge using a sterile cotton swab. Preparation of culturing media (Brain heart infusion agar plates) was prepared by suspending 52 gm of powder in 1000 ml of distilled water and then, heating to boiling to dissolve the medium completely. After that, it was allowed to cool to 45 -50 C and poured into sterile Petri plates.

### Cultivation of bacteria

1. Swabs were emulsified in 1 ml nutrient broth then three serial dilutions (10<sup>-1</sup>, 10<sup>-2</sup> 10<sup>-3</sup>) were made for each sample. This was done by adding 0.1 ml of the sample to 0.9 ml of sterile broth to make a dilution of 1:1 .The previous step was repeated to reach a dilution of 1:100 and then dilution of 1:1000.
2. The resulting samples were immediately plated in Brain Heart Infusion agar to determine the total number of microorganisms. (Figure 3)



Fig. (3): Bacterial colonies of Group C

Estimation of bacterial number Viable colonies on each petri dish were counted visually and the estimated number of colony-forming units (CFU) per milliliter was calculated.

CFU= Total number of colonies counted in the plate x inversion of saline dilution x inversion of the

cultured volume therefore: CUF ml = Total number of colonies counted in the plate x inversion of the culture volume x 1000 The number of colonies that formed under aerobic and anaerobic conditions was recorded separately.

## RESULTS

Statistical analysis was performed *with SPSS 24, Graph Pad Prism, and Microsoft Excel 2016*.

All the colonies were counted in one sector and then multiplied by the number of sectors. CFU/ml = the total number of colonies counted in the plate X 50. All data were explored for normality by using the Shapiro Wilk Normality test which revealed that data follow normal distribution accordingly independent t-test was used for comparisons.

The mean and standard deviation values were calculated for the three groups. Paired sample t-test was used to test the difference between the three groups in related samples.

Comparison between group A, Group B, and Group C showed a statistically significant difference as p-value <0.05 along the study period, where there was a statistically significant increase in bacterial growth in Group C (attachment retained removable partial denture) more than in Group B (PEEK clasp retained partial denture), and more than Group A (cast clasp retained partial denture) throughout the follow-up period.

## DISCUSSION

The aim of this study was to evaluate the microbial growth on the fitting surfaces of mandibular partial dentures retained with different designs of retainers and showed that there was a statistically significant increase in the mean colonies of microbial flora under the attachment (OT attachment) retained the removable partial denture more than that retained with PEEK retainer and cast clasp retainer through the follow-up period. This agreed with (*Rahmayani L et al 2018*), That stated that the complicated designs of the attachments and the preparation of the abutments sub-gingivally to create the finish line didn't allow the patients to pass the dental floss through interproximal spaces of the splinted crown, which may increase the frequency of periodontal disease, leads to the inadequate oral hygiene, and increase the bacterial counts.<sup>(10)</sup>

On the other hand, PEEK retained removable partial dentures showed a significant increase in biofilm formation for bacterial colonies than the metal-clasp design <sup>(11)</sup>, despite being more esthetically, and comfort accepted,<sup>(12)</sup> where the surface roughness had an impact on the bacterial adhesion to these materials when comparing the effects of both material and time. One reason for this is that the bacteria can attach easier and become sheltered in the small micrometer-scale cracks on the rougher surface. <sup>(13)</sup> The wettability of a biomaterial

TABLE (1): Mean and Standard Deviation of colony-forming unit (CFU/ml) for cast clasp, PEEK, and attachments Group during follow-up time:

Group \ Period	Cast clasp		Peek		Attachment		p-value
	M	SD	M	SD	M	SD	
At insertion	2.21	0.34	2.33	0.10	3.88	0.14	0.052*
2 weeks	0.16	2.30	2.42	0.32	3.86	0.88	0.050*
4 weeks	2.41	0.74	2.53	0.42	3.97	0.53	0.051*
6 weeks	2.45	0.82	2.41	0.77	3.77	0.46	0.053*
8 weeks	2.12	0.16	3.88	0.86	3.99	0.38	0.051*

\*: significant at the p-value.

has also been proposed to influence biofilm formation. As stated by (Hamenaka I. et al, 2016), Materials that have higher surface free energy will create a more wettable surface and are more likely to adhere to bacteria, although this depends on the hydrophobicity of the bacteria.

The changes that occurred during the time between the three groups revealed that the microbial colonization changed depending on the age of the prosthesis, where there was an increase in microbial colonization during late follow-up periods. the number of microbes increased over time as the denture base material aged.<sup>(15)</sup>

## CONCLUSION

Within the limitation of the present study, we can conclude that attachments (extra coronal “OT” attachments) used to retain removable partial dentures cause an increase in bacterial count than the metal clasp and PEEK clasp. As it needs more precise and meticulous oral hygiene measures and frequent recall visits.

## Conflict of Interest

The author declares no conflict of interest

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