

THE EFFECT OF TWO MANDIBULAR CLASS I REMOVABLE PARTIAL DENTURE DESIGNS ON THE PERIODONTAL HEALTH OF THE ABUTMENT TEETH: A RANDOMIZED SPLIT-MOUTH CLINICAL TRIAL

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ABSTRACT

The aim of this study was to assess the effect of RPI direct retainer designs in mandibular Kennedy's class I removable partial denture cases, on the periodontal conditions of their abutment teeth.

Materials and methods: A total of 10 systemically healthy Patients were selected with mandibular Kennedy class I with symmetrical healthy periodontium at first premolar abutments split mouth mandibular class I removable partial denture designs RPI, I-bar (Rest, proximal plate and I bar) in one side (side A) and a modified RPI clasp assembly (Rest, proximal plate connected by lingual bracing arm to the rest and I Bar) in other side (side B) were constructed. Clinical evaluation (gingival index, pocket depth and clinical attachment loss) and recording of GCF levels of Interlukin1 β IL1 - β using ELISA were carried out for all patients at base line (time of denture insertion), 3 months and 6 months after denture insertion at mandibular free end saddle abutments.

Results: A statistically significant increase in the mean IL-1 β levels after 3 months with further significant increase after 6 months was recorded in both sides ($P \leq 0.05$) further, side B showed a statistically increased IL- β levels compared to side A. Regarding clinical parameters, side B showed a statistical significant increase at 6 months compared to side A regarding PD with no significant difference between the 2 sides at 3 months, as for CAL and GI, although side B showed an increased readings in 6 months and 3 months compared to side A, a non significant difference was recorded between the 2 sides, as well, a non significant change in GI and CAL was recorded in both sides over the study period.

Conclusion: within the limitation of our study, the modified RPI clasp induced increasing of proinflammatory cytokines IL- 1 β levels in GCF compared conventional RPI clasp assembly. Both Clasp designs have an effect on periodontal health of free end saddle's partial denture abutments.

KEY WORDS: RPI clasp, I-bar clasp designs; RPI modifications; IL- 1 β ; mandibular Kennedy class I; periodontal health

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INTRODUCTION

According to absence of distal abutment in removable partial denture, distal extension case is developed. Part of partial denture support is gained through mucosal coverage of residual alveolar ridge and other part is from the relatively hard tooth structure (*Jorge J H et al. 2012*). According to the difference in support quality between residual ridge tissue and periodontal tissue of abutment, rotation of distal extension base occurs around fulcrum points coincide with most distal rests. Stresses and torque might be transmitted to abutment teeth in such cases. (*McCracken's et al., 12TH edit. 2012*).

Efforts were directed towards getting high residual alveolar ridge share in support through impression technique and reducing stresses that could be transmitted to abutment as a result of denture base rotation. (*El Sayed M E. 2008 and Lee H. et al 2008*, concluded that retained removable partial denture design showed more stress transmitted to abutments than that of retained by telescopic crown). Different forms and designs of direct retainers that used on distal extension base abutment were studied as a way of stress reduction. A modified form of RPI clasp assembly design was used (Rest, proximal plate and I bar), this design excluded minor connector which passes crossing free gingiva and the mesial rest connected to distal proximal plate through rigid lingual bracing arm (*Shifman A and Ben-Ur Z, 2000*). The Plaque accumulation, the condition of the periodontium, migration of the abutment teeth, deformation of the clasp arms, retention of the prosthesis, and patient preferences were assessed by (*Lee H and Hosman. 2008*). They found that removable partial denture designs did not affect plaque formation and moreover the tilting force on studied abutments showed least mobility and migration effect.

Evaluation of the effect of distal extension base movements upon Removable Partial Denture (RPD) abutments were carried out in form of clinical, radiographic, bacterial and biomarker's methods

as periodontal changes indicator (*Judy H J. 2009*). Changes in periodontal health of the abutments with different clasp designs as RPI & RPA (Rest, proximal plate and half Aker) over the follow-up period were evaluated by *El-Sheikh A M. 2007 and Archangel C M. et al., 2012* and found that well-constructed bilateral distal extension base accompanied by adequate oral hygiene instructions and regular recalls offered satisfied treatment results.

Diagnostic researches of periodontal disease were moved towards identifying and quantifying periodontal risk by objective measures, such as biomarkers isolated from gingival crevicular fluid, saliva and serum samples. Cytokine profile analysis may be explored to distinguish the periodontitis patients from the ones free of disease and also could be used as a measure of risk (*de Queiroz A C et al., 2008 and Khan Z A et al., 2011*). Since gingival crevicular fluid is closely approximated to the periodontal tissues where periodontal disease begins, it seems to provide more information than markers in saliva. In response to bacterial infection, host production of inflammatory mediators, may be the trigger for periodontal disease progression. Tissue inflammatory mediators that have been detected in the gingival tissues; gingival crevice fluid (GCF) of patients affected by periodontitis, could have a diagnostic and therapeutic significance (*Gupta G. 2013*).

Cytokines play an important role in periodontal tissue disease. It is probable that the balance between stimulatory and inhibitory cytokines, with the regulation of their receptors determines the level of periodontal tissue loss (*Graves D. 2008*).

There is an apparent evidence that periodontal destructive processes occurring as part of the host inflammatory response, responsible to high extent, in hard- and soft-tissue breakdown which finally lead to the clinical signs of periodontitis. (*Deo V., and Bhongade M L. 2010*). Moreover, *Figueredo C.M.S 1999* stated that the level of IL-1 β in gingival crevicular fluid (GCF) is considered as a

characteristic trait of periodontitis, regardless of the degree of tissue destruction. IL-1 β is a potent bone resorptive cytokine which acts in vivo by stimulating bone resorption and inhibiting bone formation. The amount of crevicular IL-1 β , is directly associated with periodontal condition and removal of the bacterial plaque with resolution of inflammation reduces its levels in GCF. (*Gamonal J. et al 2009*).

The aim of this split mouth clinical trial is to evaluate the effect of two mandibular class I removable partial denture designs RPI, I-bar and RPL clasp designs on the periodontal conditions of their abutment teeth.

SUBJECTS AND METHODS

I. Patient selection

Ten patients were selected from outpatient clinic, dental hospital, Nahda University, from mid-January 2015 till March 2016. The study population consisted of age-matched and sex-balanced subjects (5 females and 5 males; age range: 35 to 50 years). The mean age of the patients was 42.7 years. Written informed consent was obtained from participants who agreed to participate voluntarily. The study protocol was approved by the Ethical Committee of Sues Canal University. A detailed medical history of each subject was obtained according to the detailed questionnaire of the modified Cornell Medical Index (*Kerr and Millard 1965*).

II. Criteria for patient selection

Patients were systemically free and have mandibular Kennedy class I with symmetrical healthy first premolar abutments. The opposing arch was completely dentulous with accepted occlusal plane. Abutments teeth had fair periodontal condition without mobility. Clinical examination should show healthy average well attached residual alveolar ridge mucosa bilaterally for all selected cases with no apparent clinical differences between two free end saddle sides. Selected patients showed

no sign or symptom of TMJ disturbances and free from systemic diseases that could affect bone and/periodontal health. Patients selected had not received any type of periodontal treatment and had not received antibiotics or non-steroidal anti-inflammatory therapy in the past 6 months prior to examination. Pregnant, breastfeeding women, smokers or former smokers and patients with other autoimmune diseases were excluded.



Patient with mandibular symmetrical
Class I Kennedy's classification

Periodontal clinical parameters:

Periodontal examination and recording the clinical parameters were carried out for all patients at base line (time of denture insertion, 3 months and six months after denture insertion by the same examiner at mandibular free end saddle abutments. The gingival status was evaluated using the (GI) of (*Loe and Silness, 1963*), which divided tissues surrounding each tooth into four gingival scoring units: Disto -facial papilla, facial margin, mesio-facial papilla, and the entire lingual gingival margin. **Probing pocket depth (PD)** measured by the distance from the base of the pocket to the gingival margin and **Clinical attachment level (CAL)** as the distance from the base of the periodontal pocket to cement-enamel junction using William's probe. Measurements were recorded at six locations points around the circumference of each tooth. These location points were mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual

and disto-lingual. Oral hygiene maintenance was accomplished and patients were motivated for home oral hygiene measures. Periapical radiographs were taken at time of initial examination to confirm the diagnosis of periodontal diseases.

Prosthetic procedures:

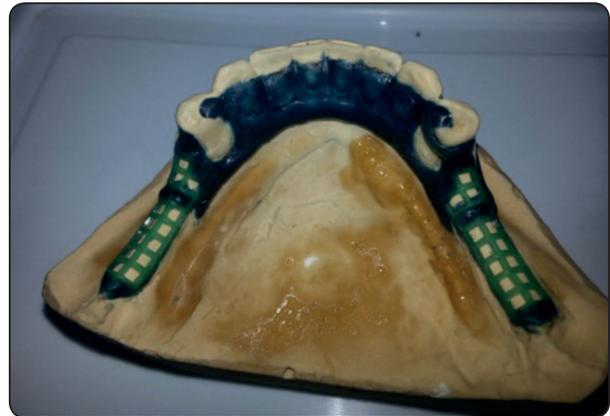
The conventional prosthetic steps were made for all patients (*McCracken's, 2011*) including preliminary alginate impression, mouth preparation for mandibular teeth and construction of acrylic custom tray. The mandibular metal frames were constructed over static mandibular casts and tried intraorally. The functional altered cast technique was followed to get final cast through using regular body rubber base impression material (*Chandrashekar S. 2010*). The routine way for pouring the final cast of free end saddle span in hard stone, recording jaw relation and completion of conventional partial denture processing were followed. For all patients partial denture design has meshwork denture base, the two studied retainer designs were constructed on bilateral mandibular first premolar abutments facing edentulous area, and lingual plate is the choice as major connector. Acrylic modified anatomic artificial teeth were used and an occlusal equilibrium was performed by laboratory remount & minimum refinement at dentures insertion.

III. Categorization of subjects:

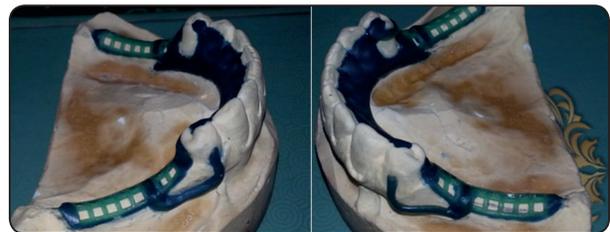
After the data collection, the patients were recalled to undergo treatment phase. The two mandibular quadrants of the mouth were randomized in order to receive one of the following selected treatments by the same operator at the same appointment. Patients mouths were divided randomly into two sides:

Side A: First premolar abutments were received conventional RPI clasp assembly on one side. (*Krol A L., 1973*).

Side B: First premolar abutments were received a modified RPI clasp assembly with lingual bracing arm connecting mesial rest to the distal plate. (*Shifman A and Ben-Ur Z. 2000*)



Two different retainer designs on 1st premolar abutments



1 bar retentive arm for both bilateral clasp assembly

IV. GCF sample collection:

The GCF samples were collected the next day after clinical and radiographic examination to prevent contamination of the GCF with blood, associated with probing. The selected site was isolated using cotton rolls to prevent contamination by saliva, sample was collected using filter paper strips for 30 second, papers suspected for being contaminated with blood and saliva were discarded. The paper strips with GCF sample was immediately transferred to an airtight plastic vial containing phosphate buffer saline. (*Wilson et al, 2003*). All vials were stored at (-70 C) until the time of IL-1 β assay. Levels of IL-1 β in GCF samples were determined by using a commercially available Enzyme- Linked Immunosorbant Assay (ELISA) from *Quantikine Kit R& D systems, USA*, **Specificity:** This assay recognizes recombinant and natural human IL-1 β . No significant cross-reactivity or interference was observed. **Sensitivity:**

Twenty assays were evaluated and the minimum detectable dose (MDD) was 1.01pg/mL. samples were collected at the same follow up periods and from the same preoperative sites.

Statistical analysis:

Numerical data were presented as mean and standard deviation (SD) values. IL-1β data showed parametric distribution; so, one-way ANOVA test was used to compare between different time periods. Tukey’s test was used for pair-wise comparisons between the mean values when ANOVA test is significant. GI, IL-1β data and % changes data of different parameters showed non-parametric distribution; so Kruskal-Wallis test was used to compare between the two groups. Mann-Whitney U test was used for pair-wise comparisons between the mean values when Kruskal-Wallis test is significant. Friedman’s test was used to compare between different time periods. Wilcoxon signed-rank test was used for pair-wise comparisons between the mean values when Friedman’s test is significant. Spearman’s correlation coefficient was used to determine significant correlations between different parameters. The significant level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

This study population included 10 patients had mandibular Kennedy class I, mean age 42.7 years. Patients’ mouths were divided randomly into two sides:

Side A: First premolar abutments were received conventional RPI clasp assembly on one side.

Side B: First premolar abutments were received modified clasp assembly with lingual bracing arm connecting mesial rest to the distal plate. The clinical parameters in addition to IL-1β were evaluated at 3 periods; base line, 3 months, and 6 months.

Clinical parameters:

At base line, the recorded values of all clinical parameters were the same for the two sides with no statistically difference between them.

(1) Pocket depth (PD):

Comparison between the two sides:

After 3 months, the recorded values of **both sides** were the same with no statistically significant difference between them. **However, after 6 months,** the recorded values in **side A** showed statistically significant reduction in the mean PD than Side B (table 1).

TABLE (1) Mean standard deviation (SD) values and results of Student’s t-test for comparison between PD of two abutments on both sides.

Group \ Period	Side A		Side B		P-value
	Mean	SD	Mean	SD	
Base line	1.7	0.4	1.6	0.4	0.210
3 months	1.7	0.4	1.9	0.5	0.125
6 months	1.9	0.5	2.6	0.8	0.031*

**: Significant at $P \leq 0.05$*

Changes by time within each group:

Concerning the changes occurred in PD within side B, there was a statistically significant increase in the mean of PD after 3 months. From 3 months to 6 months; there was also a statistically significant increase in the mean PD. On the other hand, in side A, there was non-statistically significant decrease in the mean PD after 3 months as well as after 6 months (table 2).

TABLE (2) Mean, standard deviation (SD) values and results of repeated measures ANOVA and Turkey's tests for the changes by time in PD within each group

Side \ Period	Side A		Side B	
	Mean	SD	Mean	SD
Base line	1.7	0.4	1.6	0.210
3 months	1.7	0.4	1.9	0.125
6 months	1.9	0.5	2.6	0.031
P-value	>0.001		<0.001*	

*: Significant at $P \leq 0.05$.

(2) Clinical Attachment Level (CAL):

Comparison between the two sides:

After 3 months as well as 6 months, the recorded of CAL for both sides showed no statistically significant difference (table 3).

TABLE (3) Mean, standard deviation (SD) values and results of student's t-test for comparison between CAL in the two groups

Group \ Period	Side A		Side B		P-value
	Mean	SD	Mean	SD	
Base line	0	0	0	0	0
3 months	0	0	0.6	0.1	0.211
6 months	0.7	0.2	1.1	0.9	0.323

*: Significant at $P \leq 0.05$

Changes by time within each side:

Concerning the changes occurred in CAL within side B, there was non- statistically significant changes in the mean of CAL after 3 months. From 3 months to 6 months; there was a statistically

significant increase in the mean CAL. On the other hand, in side A, there was non-statistically significant changes in the mean CAL after 3 months as well as after 6 months (table 4).

TABLE (4) Mean, standard deviation (SD) values and results of repeated measures ANOVA and Turkey's tests for the changes by time in CAL within each group

Group \ Period	Side A		Side B	
	Mean	SD	Mean	SD
Base line	0	0	0	0
3 months	0	0	0.6	0.1
6 months	0.7	0.2	1.1	0.9
P-value	0.218		<0.001*	

*: Significant at $P \leq 0.05$.

(3) Gingival index (GI):

Comparison between the two sides:

Through follow up periods, the recorded values for GI revealed a non-statistically significant difference between the both sides (table 5).

TABLE (5) Mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between GI in the two sides

Group \ Period	Side A		Side B		P-value
	Mean	SD	Mean	SD	
Base line	0.4	0.8	0.6	0.5	0.535
3 months	1.1	1.1	1.4	0.5	0.456
6 months	1.2	1.3	2.3	0.5	0.002

*: Significant at $P \leq 0.05$

Changes by time within each group:

Side A; as regarding the changes occurred in GI, there was a statistically significant increase in the mean GI after 3 months, with further statistically significant increase in the mean GI was observed after 6 months, with similar findings were shown with Side B (table 6).

TABLE (6) Mean standard deviation (SD) values and results of Friedman’s and Wilcoxon signed-rank for the changes by time in GI within each side.

Group Period	Side A		Side B	
	Mean	SD	Mean	SD
Base line	0.4	0.9	0.6	0.5
3 months	1.1	1.1	1.4	0.5
6 months	1.2	1.3	2.3	0.5
P-value	0.902*		0.002*	

*: Significant at $P \leq 0.05$

(4) Interleukin 1β (IL-1β):

Comparison between the two sides:

After 3 months as well as 6 months, the recorded values for IL-β for side B showed statistically significantly increase mean IL-1β than the Side A (table 7).

TABLE (7) Mean standard deviation (SD) values and results of Mann-Whitney U test for comparison between IL-1β in both sides.

Group Period	Side A		Side B		P-value
	Mean	SD	Mean	SD	
Base line	44.4	19.9	54.5	22.4	0.895
3 months	100.4	45.7	176.1	74.1	0.031*
6 months	210.4	126	233.6	156.4	0.009*

*: Significant at $P \leq 0.05$

Changes by time within each group:

Regarding Side A, there was a statistically significant increase in the mean IL-1β after 3 months with further statistically significant increase in the mean IL-1β was observed after 6 months, similar changes were observed in side B (table 8).

TABLE (8) Mean standard deviation (SD) values and results of Friedman’s and Wilcoxon signed-rank tests for the changes by time in IL-1β within each side.

Group Period	Side A		Side B	
	Mean	SD	Mean	SD
Base line	44.4	19.9	54.5	22.4
3 months	100.4	45.7	176.1	74.1
6 months	210.4	126	233.6	156.4
P-value	<0.001*		<0.001*	

*: Significant at $P \leq 0.05$.

DISCUSSION

The present study was conducted to investigate the efficacy of two mandibular class I removable partial denture designs, RPI and a modified form of RPI clasp, on the periodontal conditions of their abutment teeth. Patients were selected systemically free and have mandibular Kennedy class I with symmetrical healthy periodontium at first premolar abutments with completely dentulous opposing arch.

The gingival crevicular fluid (GCF) is regarded as a window for non-invasive analysis of periodontal condition (Uitto, 2003) and provide more information than markers in the serum or urine as GCF transverse the inflamed tissue (McCauley and Nohutcu, 2002). Filter paper technique was applied for GCF collection as (Ira et al, 2006) documented that because they provide satisfactory and reproducible recovery of most of the GCF proteins as well as its simplicity and cheap to assess levels of

IL-1 β reasonable in the present study (*McCulloch, 1994; Ebersole, 2003; Ozmeric, 2004*). IL-1 β is one of proinflammatory cytokines which promote periodontal destruction and thus play a decisive role in the pathogenesis of periodontitis (*Schmidt et al, 2006*).

The amount of IL-1 β in the GCF samples was determined using commercially available ELISA that is generally relatively accurate test (*Bostanci et al, 2007*). They are considered highly sensitive, specific and favorable comparable with other method used to detect substances in the body. The results of the present study showed non-significant statistical changes between groups A and B after three months of removable partial denture use. This runs with *Stipho et al. (1978)* Study which reported non-significant changes for the measured periodontal parameters. After six months of partial denture wearing, the clinical measurements showed non-significant changes in CAL and GI between the two studied groups. Concerning PD, group B showed significant changes when compared with group A. This could be due to PD changes appeared clinically before CAL and GI changes. In comparison between the two studied groups, IL-1 β showed significant increase concerning group B as it is formed in the peridontium in response to bacteria and their products after antigenic stimuli (*Gamonal et al. 2009*). RPI retainer designs were selected as *Thompson et al* study. They concluded that most favorable stresses that applied on distal abutment were with RPI system. Moreover *Clayton and Jaslow (1987) and Judy (2009)* concluded that supra bulge clasp arms exert more stresses on abutment teeth. Moreover, the bracing arm that connecting between the mesial rest and distal plate covered more surface area of the abutment. This enhances food impaction (*Deepak Nallaswamy, 2007*) and could eliminates stress releasing mechanism of the proximal plate (*Davenport, 2001*).

Finally, home hygienic measures for both prosthetic appliances and remaining natural teeth is a main factor for periodontal health with prosthetic appliances (*Stipho et al, 1978 and Isidor et al, 1990*).

CONCLUSION

Based on the results obtained from this study, the following conclusions could be formulated:

1. Clasp assembly design has an effect on periodontal health of free end saddle's partial denture abutments.
2. Efforts should be directed toward reducing torque and undue stresses on abutments facing free end saddles through using a retainer design that could release stresses away abutments and conform least tooth coverage.
3. The more the coverage of tooth surface by clasp design, the more food impaction and negatively effect on periodontal health of partial denture abutments could occur especially with short clinical crown.
4. Oral hygiene measures for periodontal and prosthetic home care and periodic recalls are detective factors on abutment periodontal condition reaction to direct retainer design.

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