Original Article

Mandibular Kennedy Class I partial denture management by broad stress distribution philosophy (radiographic assessment)

Mohammed M. Abd El-Khalik, Nesreen H. El Mekawy, Sally S. El-Kasaby

Department of Prosthodontics, Faculty of Dentistry, Mansoura University, Mansoura, Egypt

Abstract

Purpose: The objective of this study was radiographic assessment of the premolar teeth abutments alveolar bone resorption in mandibular Kennedy Class I removable partial denture (RPD) utilizing the broad stress distribution philosophy, either designed with multiple circlet clasp or compound Aker clasp.

Materials and Methods: Twelve patients were enrolled for this study with upper completely edentulous arch against mandibular Kennedy Class I ridges posterior to the second premolar. The patients were divided into two groups according to the type of the clasp assembly design used, where the mandibular Kennedy Class I RPD was designed with multiple circlet clasp and compound Aker clasp assemblies for Groups I and II, respectively. The abutment alveolar bone resorption was evaluated radiographically after 1st 6, 2nd 6, and 12 months of mandibular Kennedy Class I RPD insertion.

Results: Second premolar abutment interdental alveolar bone resorption was significantly increased as compared to first premolar abutment along the interval periods of the study for Group I. The reverse was observed for Group II. Along the interval periods of the study, the alveolar bone resorption at the first premolar abutment of Group II was significantly increased compared to that of Group I while the reverse was observed when comparing the second premolar of Group I with that of Group II.

Conclusion: Compound Aker clasp is better than the multiple circlet clasp assembly as it reduces abutment alveolar bone resorption regards broad stress distribution philosophy is considered for distal extension cases.

Key Words: Broad stress distribution philosophy, changes of abutment alveolar bone height, mandibular Kennedy Class I

Address for correspondence:
Dr. Nesreen H. El Mekawy, 1 Mecka Street from Gyhan Street Mansoura, Dakahlia 35516, Egypt. E-mail: nesreen_elmekawy@yahoo.com
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INTRODUCTION

Removable partial dentures (RPDs), which are a treatment option for replacement of missing teeth, should enhance the health of remaining dentition and surrounding oral tissues. Insertion of a partial denture constitutes a risk factor for periodontal health and supporting alveolar bone of the remaining teeth. Hence, many design philosophies for distal extension cases can be developed to preserve the supporting structure from resorption.[1]

Torqueing of the clasped teeth and possible traumatization of residual alveolar ridge is a common sequel of tissue ward

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movement of the combined tooth–mucosa–borne prosthesis around the axis of rotation in bilateral distal extension situations; this necessitates modifications of RPD design.[2]

Different methods to control the load delivered from Kennedy Class I RPDs to both teeth and residual ridges were suggested by Lammie and Laird.[3] These methods include reducing the load, distributing the load between teeth and residual ridges, and distributing the load widely.

Four design concepts are available to distribute the forces acting on a partial denture between soft tissues and abutment teeth. These include stress equalization, physiologic basing, broad stress distribution, and implant.[4]

Following wide load distribution philosophy, the forces of occlusion are reduced on any one tooth and unit area of the ridge because all the teeth and the entire available ridge collectively bear the load. Broad stress distribution is accomplished by broad denture base coverage and additional rests and multiple clasp assemblies.[5] Multiple circlet clasp and compound Aker clasp may be the clasps of choice for broad stress distribution philosophy as Phoenix *et al*.[6] stated that multiple circlet clasp design is indicated when the stresses originating from prosthesis retention can be favorably distributed between multiple abutment teeth and Lammie and Laird[3] advocated the use of compound Aker clasp for distributing the load widely.

Multiple abutments clasping for broad stress distribution philosophy will minimize rotational movement that distorting the denture during functional loading in addition to the residual ridge does not bear as much of the occlusal load.[7]

The goal of this study was to evaluate radiographically the premolar teeth abutment alveolar bone resorption in mandibular Kennedy Class I RPDs utilizing the broad stress distribution philosophy either designed with multiple circlet clasp or compound Aker clasp.

MATERIALS AND METHODS

Patient selection

A total of 12 patients were chosen, from the outpatient clinic of Prosthodontic Department, Faculty of Dentistry; their age ranged from 45 to 60 years with no systemic diseases relating to bone resorption, had maxillary complete edentulous arch against mandibular Kennedy Class I ridge. The remaining teeth extending from the second premolar on one side to second premolar on the other side, the abutments were periodontal health with no mobility, their crown/root ratio were not <1:1, distance between the gingival margin of the remaining natural teeth and the functional depth of the floor of the mouth was not < 8 mm.

The study protocol and objectives were explained to all participants before obtaining signed informed consent. The study was conducted according to the principles of the Helsinki Declaration (2013 version).

Procedures of denture construction

For all patients, periodontal treatments were done in terms of oral scaling and root planning. Maxillary and mandibular primary impressions were made with irreversible hydrocolloid impression material to produce diagnostic models. Maxillary secondary impression was made by zinc oxide eugenol impression material. The mandibular diagnostic casts were surveyed and Kennedy Class I RPDs were designed with a lingual bar which extended from right to left mandibular second premolar to connect bilateral distal extension bases and meshwork minor connector. The patients were randomly divided into two equal groups according to the clasp design: Group I: Where Kennedy Class I RPDs was designed with a multiple circlet clasp placed on the first and second premolars [Figure 1]; Group II: Where Kennedy Class I RPDs was designed with a compound Aker clasp placed on the first and second premolars [Figure 2].

Mandibular secondary anatomical impression was made with hydrocolloid impression material and poured in dental stone. For all patients after construction of mandibular metallic RPD framework, they were tried in the patient mouth [Figures 3 and 4] jaw relation was registered, the upper and lower casts were mounted on a semi-adjustable articulator using maxillary face bow for upper cast and centric interocclusal record for lower one. Monoplane artificial teeth were arranged. Mandibular Kennedy Class I RPDs opposed to maxillary complete denture were try in and processed with heat-cured acrylic resin. The finished dentures were laboratory remount for any occlusal refinement and adjustment. Intraoral adjustment of occlusion was done before denture insertion.

Figure 1: Metallic framework with multiple circlet clasp assembly design on the master cast

Figure 2: Metallic framework with compound Aker clasp assembly design on the master cast

Figure 3: Fitting of metallic removable partial denture framework with multiple circlet clasp assembly design

Figure 4: Fitting of metallic removable partial denture framework with compound Aker clasp assembly design

Evaluation abutment interdental alveolar bone height

Digital periapical X-ray film of the premolar abutment teeth was performed immediately and after 6 months and 12 months of denture insertion According to Plotnick *et al.*,[7] standardization of the periapical radiograph was performed. Corel draw 11 computer program was used to estimate abutments alveolar bone height change with a precise method according to Abd El-Khalek *et al.*,[8] by measuring the distance between the alveolar crest and the cement-enamel junction using the following reference lines and points. The reference lines are I – a horizontal tangent to the cement-enamel junction of both premolars abutment and II – a line along the long axis of the abutments. The reference points were A – first contact between bone and the mesial surface of the first and second premolars; B – first contact between bone and distal surface of the first and second premolars; C – intersecting point between a line extending perpendicular from point A and line I; D – intersecting point between a line extending perpendicular from point B and line I. The abutments alveolar bone height change was calculated for the first premolar as (CA + DB)/2. The same was done for the second premolar abutment Figures 5-8.

Statistical analysis

The data were collected and tabulated and nonparametric statistical methods were used. Mean and standard deviation were used to describe data. Mann–Whitney U-test was used to test for significance of difference in quantitative variables between the two groups. Wilcoxon signed rank test was used to test for significance of change in the same group. *P* value was considered statistically significant if < 0.05. These tests were run on an IBM-compatible personal computer using the Statistical Package for Social Sciences (SPSS) for Windows version 13 (SPSS Inc., Chicago, IL, USA).

RESULTS

The mean amount of abutment alveolar bone resorption (mm) for the first and second premolars abutments after 1st 6, 2nd 6, and 12 months from the insertion of mandibular Kennedy Class I RPDs with multiple circlet clasp assembly design Group I was 0.151 ± 0.102, 0.205 ± 0.131, and 0.364 ± 0.175, respectively, for the first premolar abutment and 0.20 ± 0.14, 0.42 ± 0.21, and 0.62 ± 0.24, respectively, for the second premolar abutment [Table 1].

The mean amount of abutment alveolar bone resorption (mm) for the first and second premolars after 1st 6, 2nd 6, and 12 months from the insertion of mandibular Kennedy Class I RPDs with compound Aker clasp assembly design Group II was 0.319 ± 0.19, 0.322 ± 0.23 and 0.64 ± 0.24, respectively, for first premolar abutment and 0.09 ± 0.08, 0.15 ± 0.11 and 0.24 ± 0.13, respectively, for second premolar abutment [Table 2].

Table 3 shows Mann–Whitney U-test for comparing the alveolar bone resorption between first and second premolar

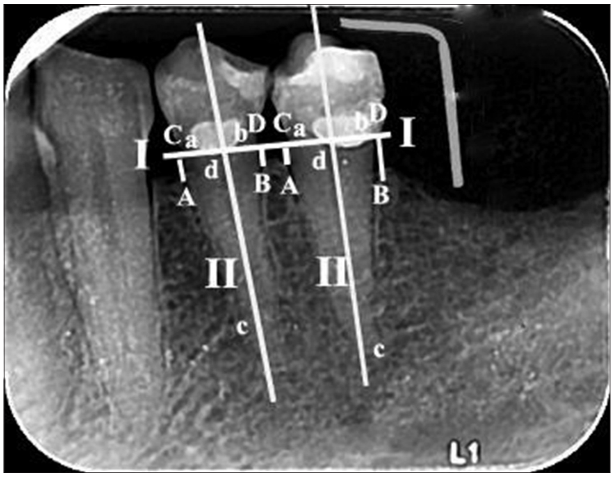

Figure 5: Digital periapical X-ray with reference lines and points for measuring Left abutments alveolar bone height at 12 months follow-up

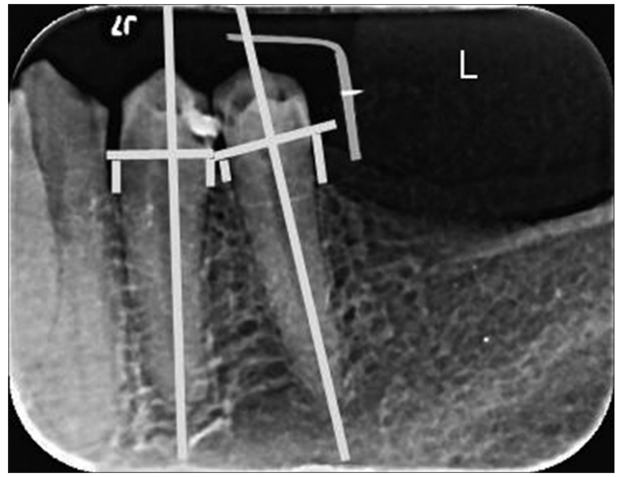

Figure 6: Digital periapical X-ray with reference lines and points for measuring left abutments alveolar bone height at 6 months follow-up

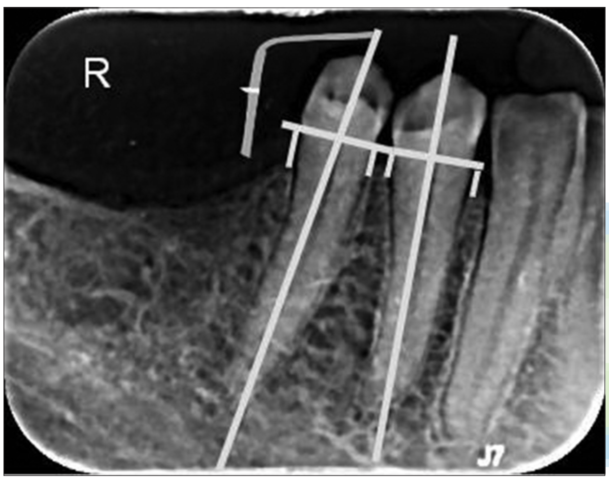

Figure 7: Digital periapical X-ray with reference lines and points for measuring right abutments alveolar bone height at 6 months follow-up

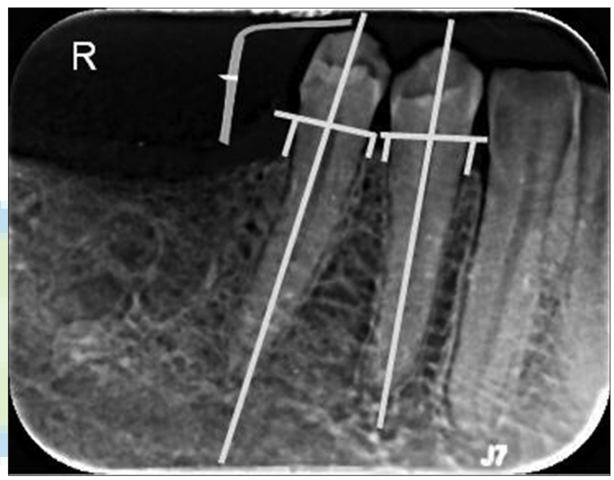

Figure 8: Digital periapical X-ray with reference lines and points for measuring right abutments alveolar bone height at 12 months follow-up

abutments of RPDs designed with multiple circlet clasp and compound Aker clasp assembly design after Ist 6, 2nd 6, and 12 months from RPD insertion.

Comparing the abutments, alveolar bone resorption between first and second premolars of Group I after 2nd 6 and 12 months of denture insertion was found to be statistically significant at $P < 0.05$ level, where $P = 0.022$ and 0.018, respectively. While for Group II, the resorption was found to be statistically significant at $P < 0.05$ level, where $P = 0.020$, 0.023, and 0.035, respectively.

Table 4 shows Mann–Whitney U-test for comparing the alveolar bone resorption of the first and second premolar abutment between RPDs designed with multiple circlet clasp and RPDs designed with compound Aker clasp after Ist 6, 2nd 6, and after 12 months from RPDs insertion.

Comparing the first premolar abutment, alveolar bone resorption between Groups I and II after Ist 6, 2nd 6, and 12 months from denture insertion was found to be statistically significant at $P < 0.05$ level, where $P = 0.021$ and 0.501, respectively. Similarly, comparing the second premolar abutment alveolar bone resorption between Groups I and II after Ist 6, 2nd 6, and 12 months from denture insertion was found to be statistically significant at $P < 0.05$ level, where $P = 0.012$, 0.021, and 0.019, respectively.

DISCUSSION

In this research, abutment interdental alveolar bone resorption for the first and second premolar was significantly observed along the interval periods of the study after insertion mandibular Kennedy Class I RPDs; this may be explained that first, with stress distribution philosophy, rigid design, the support is driven primary from abutment and secondary from the ridge and second, broad stress distribution philosophy of load cannot prevent any possible rotational movement consequently magnitude of stresses applied to abutment leading

Table 1: Mean amount of the first and second premolar abutment alveolar bone resorption (mm) along the interval period of study for (Group I)

Variable	Mean amount of abutment alveolar bone resorption (mm) for Group I					
	First premolar			Second premolar		
	After first 6 months	After second 6 months	After 12 months	After first 6 months	After second 6 months	After 12 months
X±SD	0.151±0.102	0.205±0.131	0.364±0.175	0.20±0.14	0.42±0.21	0.62±0.24

SD: Standard deviation

Table 2: Mean amount of the first and second premolar abutment alveolar bone resorption (mm) along the interval period of study for (Group II)

Variable	Mean amount of abutment alveolar bone resorption (mm) for Group II					
	First premolar			Second premolar		
	After first 6 months	After second 6 months	After 12 months	After first 6 months	After second 6 months	After 12 months
X±SD	0.319±0.19	0.322±0.23	0.64±0.24	0.09±0.08	0.15±0.11	0.24±0.13

SD: Standard deviation

Table 3: Mann-Whitney U-test for comparing alveolar bone resorption between the first and second premolar abutments of removable partial denture with multiple circlet clasp assembly design (Group I) and compound clasp assembly design (Group II) along interval period of study

Variable	Comparing abutment alveolar bone resorption between the first and second premolars of Group I			Comparing abutment alveolar bone resorption between the first and second premolars of Group II		
	After first 6 months	After second 6 months	After 12 months	After first 6 months	After second 6 months	After 12 months
Z	−0.454[a]	−2.269[a]	−2.343[a]	−1.989[a]	−-2.268[a]	−2.081[a]
P	0.691	0.022*	0.018*	0.020*	0.023*	0.035*

[a]Not corrected for ties, $*P<0.05$

Table 4: Mann-Whitney U-test for comparing the first and second premolar abutments alveolar bone resorption between Group I and Group II along interval period of study

Variable	Comparing alveolar bone resorption of the first premolar abutment between Group I and Group II			Comparing alveolar bone resorption of second premolar abutment between Group I and Group II		
	After first 6 months	After second 6 months	After 12 months	After first 6 months	After second 6 months	After 12 months
Z	−0.523[a]	−2.026[a]	−2.335[a]	−1.689[a]	−2.220[a]	−3.406[a]
P	0.501	0.021*	0.018*	0.012*	0.021*	0.019*

[a]Not corrected for ties, $*P<0.05$

to its interdental alveolar bone resorption. For this reason, anatomical impression was used in this study to achieve this philosophy. Phoenix *et al.*[6] pointed out that philosophy of broad stress distribution believed that there are no flexible or moving parts that distorting the denture, the residual ridge does not bear as much of the occlusal load.

In this study, the second premolar abutment interdental alveolar bone resorption was significantly increased compared to the first premolar abutment along the interval periods of the study after insertion mandibular Kennedy Class I RPDs designed with multiple circlet clasp (Group I), this may be explained that as the retentive terminal of clasp of last abutment located (mesially) away from the saddle as similar to Aker clasp. On other word, during tissue ward movement of the prosthesis under functional loading, the retentive terminal of clasp arm located on second premolar will engage more undercut, this in turn exaggerates more load to the second premolar abutment. While on the first premolar abutment tooth ,as the result of the two reciprocal arms are connected together, increase the rigidity of multiple circlet clasp, this will prevent the disengagement of retentive terminal of the clasp that located at first premolar. By this way, the first premolar is subjected to less stresses compared to second premolar. Carr *et al.*[9] stated that Aker clasp has a rest originates from the proximal tooth surface of abutment tooth adjacent to edentulous area and clasp arm terminal engage undercut away from edentulous area, if it is used in tooth mucosal supported RPD rotation occurs during tissue ward movement, the retentive terminal clasp arm will engage more undercut create excessive stresses to abutment.

In this examination, first premolar abutment interdental alveolar bone resorption was significantly increased compared to second premolar abutment along the interval periods of the study after insertion mandibular Kennedy Class I RPDs designed with compound Aker clasp (Group II), this may be due to tissue ward movement of the prosthesis along the fulcrum axis passing through 2 principle abutment located mesial to the second premolar, the retentive terminal of the clasp located in the second premolar, near to the saddle, may disengage the undercut; this will minimize the load applied on the second premolar abutment during functional loading. Alternatively, the retentive terminal of the first premolar engages more undercut, this in turn excessive load applied to this abutment. Both engagement and disengagement of undercut of retentive terminal occurred at the same time as the prosthesis move tissue ward because the compound clasp is considered double Aker shared together with common minor connector. Phoenix *et al*.[6] mentioned that the reverse Aker clasp may favorably control stresses delivered to the abutment upon loading of the RPDs. As the extension base moves toward the underlying tissue, the clasps retentive terminal moves into an area of greater undercut minimizing torsional stresses on abutment.

In this research, first premolar abutment interdental alveolar bone resorption of Group II (designed with compound Aker clasp) was significantly increased compared to first premolar abutment of Group I along the interval periods after insertion mandibular Kennedy Class I RPDs. Alternatively, second premolar abutment interdental alveolar bone resorption of Group I was significantly increased compared to second premolar abutment of Group II along the interval periods after insertion mandibular Kennedy Class I RPDs. The explanation of this result may be reinforced by the result obtained in this study when comparing abutment alveolar bone resorption of the first and second premolar independently between the 2 groups together where for Group I exhibit greater alveolar bone resorption at first premolar compared to that of Group II, the reverse result was found in second premolar.

In summarizing the result according to Memari *et al*.,[10] preservation of the abutment adjacent to distal extension is the goal of prosthetic treatment option for this reason compound Aker clasp is the selected retainer unit to preserve abutment alveolar bone from resorption when broad stress distribution design philosophy is the prosthetic treatment option for mandibular Kennedy Class I RPDs.

CONCLUSION

Compound Aker clasp is better than the multiple circlet clasp assembly as it reduces abutment alveolar bone resorption regards broad stress distribution philosophy is considered for mandibular Kennedy Class I cases.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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