EGYPTIAN DENTAL JOURNAL
VOL. 65, 1897:1905, APRIL, 2019
I.S.S.N 0070-9484
FIXED PROSTHODONTICS, DENTAL MATERIALS, CONSERVATIVE DENTISTRY AND ENDODONTICS
www.eda-egypt.org • Codex : 220/1904

THE EFFECT OF USING DIFFERENT DESIGNS ON DISTAL IMPLANT FOR TREATMENT OF MANDIBULAR KENNEDY CLASS II CASES

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ABSTRACT

The Purpose of the current study was to evaluate radiographically the effect of using OT CAP, OT unilateral and magnet extra-coronal attachments placed on second premolars with different RPD designs on the distal implant placed in mandibular unmodified kennedy class II cases. **Materials and methods**: Twenty-one patients having unmodified mandibular kennedy class II with distal implant installed in the molar region. Group I patients were rehabilitated with an implant assisted removable bilateral partial denture retained by ball and socket extra-coronal attachment (OT CAP attachment Rhien 83, Italy). Group II were rehabilitated with an implant assisted removable bilateral partial denture retained by magnet attachment (Dyna system magnet). Group III Patients were rehabilitated with unilateral (side plate) removable partial denture retained by another design of extra-coronal attachment (OT unilateral Rhien 83, Italy). Peri-implant marginal bone loss was evaluated around the distal implant in each group using standardized periapical intra-oral radiographs using a long cone paralleling technique. The peri-implant marginal bone loss was measured at the time of loading of the distal implant (0 month), after 6 months and 12 months. **Results:** There was no statistically significant difference in the mean marginal bone loss (P> 0.05) between the OT unilateral, magnet and OT CAP attachment groups at 0-6 months follow up interval. There was a statistically significant difference in the mean marginal bone loss around the distal implant between the three groups in the (6-12 months) and (0-12 months) follow up intervals. The highest peri-implant marginal bone loss was recorded in group III with the unilateral partial denture design. **Conclusion**: Within the limitation of this study it could be concluded that although enrolling extracoronal attachments in the design of Kennedy class II is acceptable as a treatment modality, the unilateral design may cause the highest bone resorption around the distal implant.

INTRODUCTION

Success of prosthetic rehabilitation should cover both functional and esthetic requirements. It requires careful attention and meticulous treatment planning. Precision attachments offer considerable advantages in dentistry because of their flexibility.[1] Free end saddle remains a challenge that face prosthodontist as it should fulfill mechanical and esthetic requirements.

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Distal – extension removable partial dentures (DISRPD) provide several challenges in relation to retention, stability, support and masticatory efficiency [2]. The design of a mandibular free-end base removable partial denture (RPD) should contain a stress-releasing concept to avoid torque force acting upon abutment tooth [3]. This may require a specific design of direct retainer and location of the rest to induce axial force direction [4]

The use of dental implants beneath a distal extension denture base, substitute the role of tooth roots in enhancing the support and stability of RPDs reducing bone resorption and maintaining ridge height [5]. Depending on the implant location, the free-end base RPDs can be converted into Kennedy Class III and eliminate the development of fulcrum line [6,7].

An invitro study indicated that implant placement at the distal edentulous ridge can prevent denture displacement of the distal extension bases, regardless of the supporting area of the denture base. [8]

Magnets offer little resistance to lateral prosthesis movements, which are usually difficult to control during load application. This character may help to dissipate potentially damaging lateral forces on implants and at the same time transmit these forces to the abutment teeth through clasps. [9]

It was detected that the load on the abutment tooth was significantly greater with distal Implant Supported RPD than with Conventional RPD, despite the presence of the supporting implant. With DISRPD, the applied load was mainly distributed to the implant and the abutment tooth, unlike the situation with Conventional Removable Partial Denture. In other words, the role of the abutment tooth with DISRPD (pseudo Kennedy class III) resembles the role it serves with bridges for long-span defects [10,11]

Implant-assisted partial dentures can be considered as an intermediate prosthodontic solution between a conventional RPD and a fixed implant-supported restoration. They can be modified towards either of these 2 directions: they can be converted to a conventional RPD in case of failure of the implants, or they can be replaced by an implant-supported fixed partial denture by placing additional implants. It is therefore a highly versatile type of restoration that does not alter the patient's dental condition in an irreversible manner [12]

The objective of the current study is to evaluate radiographically the effect of using OT CAP, OT unilateral and magnet extra-coronal attachments placed on second premolars with different RPD designs on distal implant placed in mandibular unmodified Kennedy class II cases

MATERIALS AND METHODS

Participants

Twenty-one partially edentulous patients who had unmodified mandibular Kennedy class II with the second premolar being free end abutment, were selected from the Out Patient Clinic, Prosthodontic Department, Faculty of Dentistry, Ain shams University. The entire patient showed sufficient occluso-gingival height of the abutment clinical crown with opposing intact arch dentition or restored with acceptable fixed restoration. Radiographic examination was done using cone beam computed tomography (CBCT) machine (Scanora3D, Sorredex- Finland, 15mA, 85 KV). it was performed to ensure sufficient bone in second molar region for implant installation.

Surgical procedure

All the participants received distal implant (IS implant system, Neobiotech, Seoul, South Korea) at the molar region following the conventional two surgical stage procedure and was done by the same clinician. The implant was exposed after 3 months to ensure osseointegration and a ball and socket abutment was screwed to the implant to assist the removable partial denture. (fig 1)

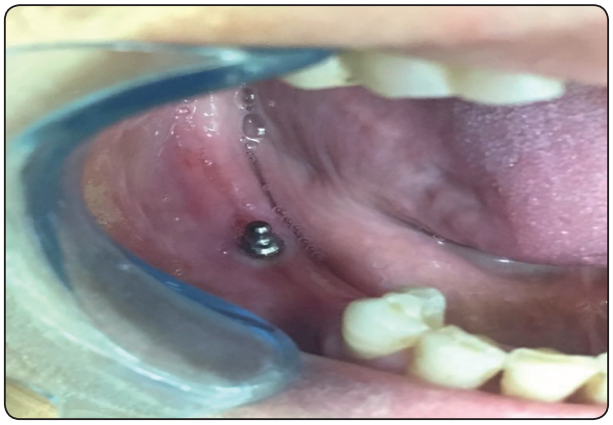

Fig. (1) installation of distal implant

Patients grouping

The patients were then randomly assigned using random number generator and checker (* www.psychicscience.org/random.aspx) into three equal groups.

Group I patients were rehabilitated with implant assisted removable partial denture retained by ball and socket extra-coronal attachment (OT CAP attachment Rhien 83 Italy) with bilateral (conventional) partial denture design.

Group II Patients were rehabilitated with implant assisted removable partial denture retained by magnet attachment (Dyna system magnet) with bilateral(conventional) partial denture design.

Group III Patients were rehabilitated with unilateral (side plate) removable partial denture retained by other design of extra-coronal attachment (OT unilateral Rhien 83 Italy).

Prosthetic procedure

For group I and III the first and second premolar were prepared to receive splinted crowns while for group II the second premolar was endodontically treated and prepared

Primary impressions were made using alginate impression material in a suitable stock tray then poured in dental stone to obtain the primary casts on which individual trays were constructed on a 2mm spacer. The lower first and second premolars on the partially edentulous side were prepared with a deep chamfer finishing line extended sub-gingivally (0.5-1mm) with sufficient occlusal (2-2.5mm) and circumferential reduction (1-1.5mm) to receive two full porcelain veneered crowns. Gingival margin of the prepared abutments was retracted by retraction cord before impression making. Finally, putty impression was made using putty and light bodied rubber base (Xantopren, Kulzer, Germany). The impression was then washed, inspection and poured in extra-hard dental stone.

Group I received bilateral partial denture following the principal of cross arch stabilization of the prosthesis through a lingual plate major connector and retained by a Double Aker's clasp on the dentulous side and OT CAP extra-coronal attachment joined to two casted crowns splinting the first premolar and second premolar of the edentulous side. A ledge was prepared on the lingual surface of the first and second premolar wax pattern to receive a lingual bracing arm; The Double Aker's clasp was placed on the second premolar and the first molar. The terminal ends of the lingual plate act as indirect retainer through lingual rests on the canines. Metal try-in of the crowns-attachment assembly was carried-out intra-orally. Any necessary adjustments were made until complete and precise seating of the crowns was achieved. The porcelain shade was then selected to match the remaining natural teeth, and the porcelain was built-on the two metal crowns the final crowns-attachment assembly were tried-in the patient's mouth, and temporary cemented. On the intact side, preparation of occluso-distal rest seat on the second premolar and occluso-mesial rest seat on the first molar were prepared 1.5 to 2 mm depth using suitable size diamond round bur. Buccal and lingual embrasures between them were widened to accommodate the minor connectors attached to the mesial and distal occlusal rests. Lingual rest seat or cingulum rest seat were prepared on the lingual surface of the lower canines for the lingual plate. Then an overall rubber base pick-up impression of the crowns' attachment assembly was made the

impression was poured in dental stone to obtain a master cast, and the master cast was modified and duplicated into refractory cast. On the refractory cast, wax pattern of the RPD framework was built-up. The metal framework of the removable partial denture was tried in the patient's mouth to verify its passive fit, the accuracy of the casting, complete seating of the rests in their rest seats Any necessary occlusal adjustments were made. Altered cast impression technique for the distal extension was made. Centric occlusion relation was registered by wax wafer method. Casts were then, mounted on semi adjustable articulator. Semi anatomical cross-linked acrylic teeth were set up and try –in was carried out in the patient's mouth. Occlusion was refined in the patient's mouth at the time of delivery. The retentive cap was snapped into the fitting surface of the denture using retentive caps inserting tool. Final Cementation of the crowns attachment assembly using glass ionomer cement, the patient was asked to come next day for final delivery of the RPD (fig. 2).

Group II received bilateral partial denture following the principal of cross arch stabilization of the prosthesis through a lingual plate major connector and retained by a Double Aker's clasp on the dentulous side. For magnetic retained partial dentures, root canal treatment was carried out for the abutment teeth. Reduction of the occlusal surface was carried out to decrease the height of the abutments to 2mm above the gingival margin in order to create sufficient space for the magnet and the keeper. The abutments were prepared, by the special drill (called seat drill) supplied by the manufacturer (Dyna Magnet System) parallel to the long axis of the abutment to remove gutta-percha and to prepare the keeper space inside the root canal in order to receive the small size (4mm in length and width) keeper in its correct position, direction, and depth . Then the keeper was cemented using resin cement. At least 1mm clearance space was created all-around the small size magnets (4.8mm in diameter and 1.7mm in height) by grinding enough resin from the fitting surface of the denture base, opposite to the keeper (fig 3 a, b).

Group III: Patients of this group were treated with unilateral (side plate) removable partial denture retained by OT unilateral extracoronal attachment in which: The intact side of the lower arch did not receive any preparation. The partially edentulous side received the same preparation for the last abutments (first and second premolars) as in the first group. The crowns-attachment assembly was permanently cemented finally using glass ionomer cement. The retentive cap was replaced in group I (the OT CAP attachment) every 6 month while in group III (OT Unilateral attachment) once a year. (fig 4)

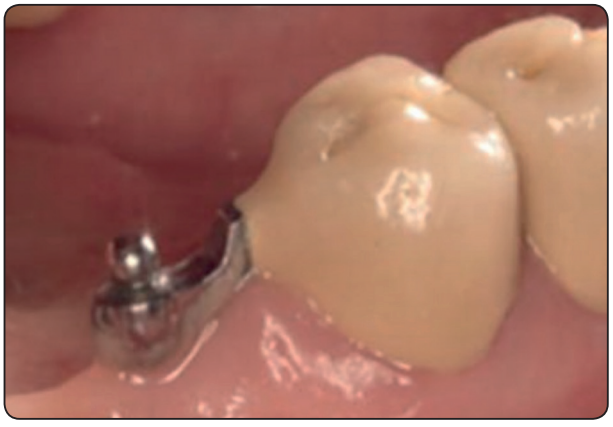

Fig. (2) OT CAP attachment fixed to splinted abutment

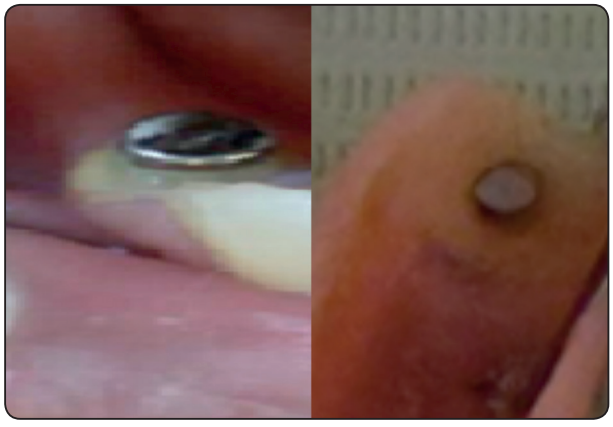

Fig. (3) a) Keeper fixed on the prepared abutment. b) Magnet fixed in the fitting surface of partial denture

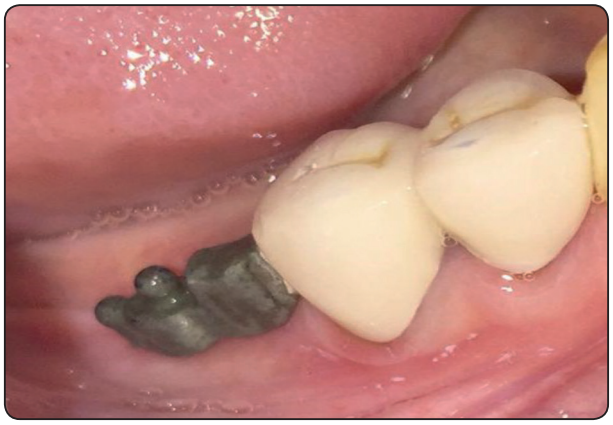

Fig. (4) OT unilateral attachment fixed to splinted abutments

In the three groups, radiographic evaluation was done using Standardised peri-apical intra-oral radiographs using a long cone paralleling technique (Dentsply Rinn's XCP and positioning ring; Dentsply Ltd) to detect the peri-implant marginal bone level mesial and distal to the implants. Images were analyzed by special linear measurement Digora software (version 1.51 for windows). This was done at the time of loading (0 month), six months and twelve months after implant loading. The collected data was organized, tabulated and statistically analyzed.

RESULTS

Twenty-one partially edentulous patients who had mandibular Kennedy class II received twenty-one distal implant at the molar region. All the implants showed successful osseointegration during the whole follow up periods. During the follow-up periods, the peri-implant marginal bone loss was measured around the distal implant in each group (OT CAP, magnet and OT unilateral). It was measured at the mesial and distal of the implant in each group at the different follow up patient visits. The peri-implant marginal bone loss was measured at the time of loading of the distal implant (0 month), after 6 months and 12 months. the mean of the mesial and distal the peri-implant marginal bone loss was calculated. To evaluate the effect of time on peri-implant marginal bone loss the follow up periods were divided into 2 intervals; the 1st follow up interval (0 to 6months after loading) and the 2nd follow up interval (6 to 12months after loading).

The mean peri-implant marginal bone loss at different surfaces and their standard deviations in all patients for the distal implants in group I, II and III separately at the follow up intervals were calculated. The data was collected, tabulated and statistically analysed using Statistical analysis was performed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). A paired t- test was conducted between the mean marginal bone loss around the distal implant in each group separately at the follow up intervals. P- values <0.05 were considered statistically significant.

The mean peri-implant marginal bone loss in the 0-6 months interval was 0.491± 0.076, 0.46± 0.089 and 0.52± 0.082 in group I, II and III respectively. The mean peri-implant marginal bone loss in the 6-12 months interval was 0.262± 0.05, 0.311± 0.058 and 0.557± 0.061 in group I, II and III respectively

There was a statistically significant difference in the Peri-implant marginal bone loss in group I and II around the distal implant between the 0-6 months and 6-12 follow up intervals as the p-value was < 0.05. In Group III, there was a statistically insignificant difference in marginal bone loss around the distal implant between the 0-6 and 6-12 months follow up intervals as the p-value was > 0.05. (table 1, 2, 3)

TABLE (1) Showing a paired t-test the marginal bone loss between follow up intervals in Group I

	0-6 months	6- 12 months	p- value
Mean	0.491	0.262	0.001
Standard deviation	± 0.076	± 0.050	

TABLE (2) Showing a paired t-test the marginal bone loss between follow up intervals in Group II

	0-6 months	6-12 months	p- value
Mean	0.46	0.311	0.017
Standard deviation	± 0.089	± 0.058	

TABLE (3) Showing a paired t-test the marginal bone loss between follow up intervals in Group III

	0-6 months	6- 12 months	p- value
Mean	0.52	0.557	0.358
Standard deviation	± 0.082	± 0.061	

To evaluate the effect of attachment type and design on the peri-implant marginal bone loss, the follow-up periods were dived into three intervals (0-6), (6-12) and (0-12) months. The data collected was analyzed with ANOVA test in the three groups. The P-values < 0.05 were considered statistically significant. (table 4)

At the 0-6 months follow up interval, there was no statistically significant difference in the peri-implant marginal bone loss (P> 0.05) between the three groups. At the 6-12 and 0-12 months follow up intervals there was statistically significant difference in the peri-implant marginal bone loss (P< 0.05) between the three groups. Accordingly, a TUKEY test was done to compare each two groups together at the 6-12 and 0-12 months follow up intervals.

At the 6-12 months follow up interval, there was a statistically significant difference in the peri-implant marginal bone loss between group II and group III (P-value <0.05). Likewise, there was a statistically significant difference in the peri-implant marginal bone loss between group I and group III (P-value <0.05). No statistically significant difference in the peri-implant marginal bone loss was found between group II and group I at the 6-12 months follow up interval (P-value >0.05).

At the 0-12 months follow up interval, there was a statistically significant difference in the peri-implant marginal bone loss between group II and group III (P-value <0.05). Similarly, there was a statistically significant difference in the peri-implant marginal bone loss between group I and group III (P-value <0.05). No statistically significant difference in the peri-implant marginal bone loss was found between group II and group I at the 6-12 and 0-12 months follow up intervals (P-value >0.05). (table 5)

TABLE (4) Showing ANOVA test the marginal bone loss between follow up intervals in Group I, II and III.

Attachment type	0-6 months		6-12		0-12	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Group I (OT CAP)	0.49	± 0.076	0.262	± 0.050	0.75	±0.078
Group II (magnet)	0.46	± 0.089	0.311	± 0.058	0.77	±0.091
Group III (OT unilateral)	0.52	± 0.082	0.557	± 0.061	1.07	±0.106
P value	>0.05		< 0.05		< 0.05	

TABLE (5) Showing TUKEY test the marginal bone loss between follow up intervals in Group I, II and III.

Follow up interval	**(Group II) / (Group III)**	**(Group II) / (Group I)**	**(Group I) / (Group III)**
6-12 months	P value < 0.05	P value > 0.05	P value < 0.05
0-12 months	P value< 0.05	P value > 0.05	P value< 0.05

DISCUSSION

Free- end saddle cases represent a challenge in prosthodontics especially that its restoration is complicated by mechanical, biological and esthetical problems. The rotation of removable partial denture yields harmful torque forces to abutment tooth. Continuous pressure from the denture base gradually causes ridge resorption under the denture base. Placing implants underneath distal extension denture base of a removable partial denture can provide improved retention and stability of partial denture, enhanced chewing efficiency and conversion of Kennedy class II cases to Kennedy class III [13]. The elimination of clasps and the use of attachments satisfied the esthetic expectations of the patients. Reduced displacement of the denture base led to better tissue tolerability and increased options for RPD use [5].

Most of the research work was directed to evaluate the effect of implant placement in distal extension cases on the abutment and the distal implant. Few studies were conducted to clarify the effect of different partial denture designs and attachments on the abutment teeth on the distal implant in unilateral distal extension cases [14,15]. In the current study, the effect of three different partial denture designs and attachments used on the abutment teeth was assessed on the marginal bone loss around the distal implant in Kennedy class II cases. Although there was statistically significant difference in peri-implant marginal bone loss around the distal implant between the study groups during the follow-up periods yet the peri-implant marginal bone loss around the distal implant in the three groups did not exceed the normal range (1.5 mm) of any successful implant during the first year.[16] This result is in agreement with the results of similar studies which evaluated the peri-implant marginal bone loss around the distal implant inserted to assist partial dentures in free end saddle cases. [17,18]

Clinical use of removable partial denture with unilaterally designed framework in patients with unilateral edentulism in the molar region is claimed to be more comfortable to the patient especially during speech, mastication and swallowing. An advantage of this restoration is the avoidance of an extensive lingual or palatal major connector with more profound effect on patients' acceptance due to its relative simplicity [19]. Nevertheless, unilateral design of removable partial dentures is criticized due to lack of cross arch stabilization, diminished retention and undue stresses falling on the residual ridge [20-23]. The lack of cross arch stabilization may lead to difficulty in restoring masticatory function due to damaging lateral forces transmitted to abutment teeth and oral tissues during excursive movements leading to the dislodgement of the prosthesis and the risk of swallowing. [24] Using dental implant as a distal abutment can convert a Kennedy class II to a Kennedy class III changing the support of the RPD from being tooth-tissue supported to tooth-implant supported and assisted RPD [6,7,25]. This implant placed posteriorly provides a definite stop eliminating the problems of distal extension RPDs [26].

In group III the applied design was unilateral (side plate) removable partial denture retained by OT unilateral extracoronal attachment. Using OT unilateral attachment with its double settings improved the retention and eliminated the need for cross arch stabilization, which might resemble the

fixed prosthetic treatment elevating the patients' acceptance. This could explain the statistically insignificant difference in the marginal bone loss around the distal implant between the OT unilateral, magnet and OT CAP attachment groups in the (0-6 months) follow up interval. This finding was concluded and confirmed in other studies [14, 27].

There was a statistically insignificant difference between the peri-implant marginal bone loss in group III between the 0-6 and 6-12 months follow up intervals. This might be explained by increased retention quality of the OT unilateral attachments, better patients' acceptance, security and increased motivation to use unilateral prosthesis side giving the sensation of fixed restoration. This finding was confirmed by a similar study. [28] This might have led to increased occlusal stresses on the abutment and the distal implant leading to continued rate of peri-implant marginal bone loss in group III in the 6-12 months follow up interval.

The unilateral designed partial denture in group III lacks an important quality which is the cross-arch stabilization which is provided in group I and II. [29] In the conventional design in group, there is also added retention provided by the double Aker clasp in the dentulous side. Owing to these missing qualities in the unilateral partial design, there might have been uneven load distribution between both sides of the mandibular arch and increased vertical and lateral forces on the prothesis side. This might explain the statistically significant difference in the per-implant marginal bone loss in group III compared to group I and group II separately at the 6-12 and 0-12 months follow up intervals. These results contradict the results of another similar study which deduced that there was statistically no significant difference in the marginal bone loss around the distal implant between unilateral (side plate) and bilateral (conventional) implant-assisted partial denture. [14] This can be attributed to the use of an extracoronal resilient ball and socket attachment as a retainer splinted to the canine and first premolar in the unilateral partial denture in the latter study which might have dissipated some of the occlusal load falling on the distal implant providing a stress breaking action. Thus, the use of unilateral partial denture design in implant assisted partial denture in Kennedy class II cases needs further investigation regarding the type of direct retainer and attachment used.

CONCLUSION

Within the limitation of this study it could be concluded that although enrolling extracoronal attachments in the design of Kennedy class II is acceptable as a treatment modality, the unilateral design may cause the highest bone resorption around the distal implant.

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