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Research Article

Which is better for Principle Abutments in distal Extension Cases : Ball or Ot-Equator Attachment ? A Research Article

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Abstract

Objective: This clinical study was done to compare between different designs of solitary attachments used to retain implant assisted mandibular distal extension Removable Partial Overdenture regarding alveolar bone height changes around abutment teeth.

Methods: Twelve patients with mandibular Kennedy Class I were selected for this study. The remaining natural teeth were extended from the first premolar on one side to first premolar on the other side. One implant was placed bilaterally in each first molar region. The removable partial dentures were retained anteriorly by RPA clasp designs on mandibular 1st premolars and posteriorly either by ball attachment (group A) or by OT-equator attachment (group B). Alveolar bone height changes around the primary abutment teeth were radiographically evaluated using Cone Beam CT (CBCT) immediately (T0), 3 months (T3), 6 months (T6) and 9 months (T9) after definitive loading.

Results: At the end of the study, the measured abutment alveolar bone height resorption in ball attachment group (0.72 ± 0.15) significantly (p value = 0.008) showed less alveolar bone resorption when compared to OT-equator attachment group (1.01 ± 0.25).

Conclusion: Within the limitations of the present study, ball attachments are more advantageous than OT-equator attachments for retaining Implant assisted distal extension removable partial overdenture regarding the preservation of abutment alveolar bone height.

Keywords: *Dental Implant; Implant Retained Overdenture; Bilateral Free End Saddle; Kennedy Class I Classification; Ball Attachment; OT-Equator Attachment*

Abbreviations

DERPD: Distal Extension Removable Partial Denture; ISRPOD: Implant Supported Removable Partial Overdenture; DICOM: Digital Imaging and Communication in Medicine; CHx: Chlorohexidine; VBL: Vertical Bone Loss; HBL: Horizontal Bone Loss

Introduction

Distal Extension Removable Partial Denture (DERPD) is one of the treatment modalities for bilateral edentulous areas located posterior to the remaining natural teeth (Kennedy class I). However, these cases present treatment problems originating from dual support of the prosthesis [1].

The compressibility of the tissues under the saddle is greater than that of the tooth, and it increases posteriorly toward the region of the retromolar pad. Monteith [2] advocated that the denture bearing tissue has a displacement range 20 times as the periodontal ligaments surrounding the abutment tooth. Therefore, the abutment tooth tends to be displaced very slightly in comparison to the soft tissues covering the residual alveolar ridge under vertical forces. Moreover, multidirectional rotational movement will occur to the DERPD under functional loading which generates greater potential damage for the supporting tissues [3].

Placing dental implants at the distal end of the edentulous area effectively converts Kennedy class I RPD to a Pseudo Kennedy class III RPD. This treatment option with using fewer implants is economic, more stable. Therefore; it is a better option for patients with limited financial resources in comparison to implant-supported fixed partial denture [4]. Additionally, implants placed under RPDs provide support, increase stability, maintain bone in the posterior edentulous areas, and offer a cost-effective treatment [5].

Mijiritsky., *et al.* [6] reported that implant assisted RPD wearers had improved chewing ability with increased maximum muscular function and higher patient satisfaction. In this sense, implants incorporated into RPD which provide support through the use of healing caps, are termed Implant Supported Removable Partial Overdenture (ISRPOD). The term Implant Retained Removable Partial Overdenture IRRPOD described the use of resilient attachment to improve the retention as well [7].

Resilient attachments usually require a large space and might cause posterior mandibular resorption with the vertical movement of the denture base while the non-resilient types do not permit any movement of the overdenture during function and were commonly employed when the interocclusal space was limited [8].

Ball attachments are widely used as the simplest among all stud attachments because of their low-cost, ease of handling, minimal chair side time requirements and their possible applications with both root and implant supported prostheses [8,9].

However, OT-Equator design combines the simplicity of ball attachments and offer many unique benefits that the other systems lack. A significantly lower height and smaller diameter, hygiene-friendly construction, and simple affordability are the primary advantages [10].

There were few studies investigating the effect of equator design on the tooth abutment supporting RPD. Therefore, this study compared between two different solitary (ball vs. OT-equator) attachments used to retain implant assisted mandibular distal extension RPD regarding abutment alveolar bone height changes.

Materials and Methods

Twelve patients had completely edentulous maxilla opposed by partially edentulous mandible with remaining first premolars and six anterior teeth with healthy periodontal condition. They were indicated for maxillary single denture opposing mandibular bilateral DERPD.

Maxillary and mandibular alginate preliminary impressions (cavex CA37 fast set, Holland) were made and poured in dental stone to make study casts. Maxillary and mandibular custom trays were constructed using autopolymerized acrylic resin (Acrosome, Egypt).

After border tracing, maxillary secondary impression was made using zinc oxide eugenol impression material (Cavex, Holland) and mandibular final impression was made using acrylic custom tray and condensation silicone impression material (Protesil, Italy). Both impressions were poured in dental stone to produce master casts on which record blocks were made.

Record blocks were adjusted intraorally and orientation relation was recorded using face bow to mount maxillary cast on semi-adjustable articulator. Vertical and horizontal jaw relations were recorded and the mandibular cast was mounted on the articulator.

The shade and colour of artificial teeth were selected then semi-anatomical artificial teeth were arranged into lingualized balanced occlusion. The waxed up trial dentures were tried in the patient mouth then processed, finished and polished before delivery to the patient.

After acrylic dentures processing, the occlusion was evaluated intraorally and adjusted before delivery of the upper complete and lower partial denture. Recall was done to manage any patient complaint.

A stereolithographic 3D surgical guide was constructed by using dual scan technique according to Spector 2008 [11] as follows: Ten to twelve radiographic markers are placed in a staggered pattern and at different levels to the occlusal plane on the buccal flanges and lingual surfaces of mandibular acrylic temporary RPD. The marker in each site was prepared with a #4 round bur to approximately 2-mm wide and 1.5-mm deep and filled with softened gutta percha. Dual scan cone-beam CT technique was made using the acrylic mandibular RPD as a radiographic template.

The Digital Imaging and Communication in Medicine (DICOM) 3D formatted files are then imported into the software and the data are converted into three-dimensional representations of the patient's alveolar bone and of the radiographic template.

According to planning the virtual prosthesis in exact relationship to the underlying bone, the implants can be virtually placed in the available alveolar bone. The internal diameter of the guide sleeve of the surgical guide corresponds precisely to the diameters of the drill guides for each implant. The surgical guide was modified by extending it to cover the occlusal and incisal surfaces of the remaining teeth instead of using the stabilization pins.

Before using the stereolithographic surgical guide, the patient was instructed to rinse with Chlorohexidine mouth wash (CHx) for 30 seconds. Single implants were inserted in the 1st molar areas of the mandible bilaterally. The patient was given intramuscular 1 gm amoxicillin combined with clavulinic acid and 50 mg Diclofenac potassium as an anti-inflammatory one hour prior to the surgery.

After the local anesthesia was injected, the surgical guide was placed and exactly seated on the underlying mucosa and remaining teeth (Figure 1). A tissue punch was used to remove a core of gingiva from each guide sleeve corresponding to the selected implant sites.

Figure 1: *Stereolithographic surgical guide fitted in the patient's mouth.*

Successive-sized drills were used to prepare each implant site to the exact position and depth as determined by the surgical guide. All drills were externally irrigated with copious amounts of cold saline, and were used in a "pumping" fashion. Implant fixtures had been inserted in each 1st molar area bilaterally and finally seated subcrestally about 1 mm. After surgery, suitable healing abutments were screwed into the fixtures. Post–surgical digital panoramic x-ray was performed to verify implants position.

The acrylic temporary RPD was relieved at the sites of implant healing abutments and filled with tissue conditioner. All patients were instructed for maintaining a soft diet for 6 weeks and rinsing with 0.12% chlorhexidine gluconate solution. After one week of implant insertion, the tissue conditioner was replaced by silicon soft liner for additional two weeks.

A mandibular preliminary alginate impression was performed after one month from the surgery and poured in dental stone to produce mandibular preliminary cast. Surveying the diagnostic cast using dental surveyor and the definitive RPD was designed including; lingual bar major connector, RPA clasp assembly on the 1st premolars bilaterally, and meshwork minor connector modified around the implants by cutting bilateral circular hole in relation to the healing abutments heads (Figure 2).

Figure 2: *Metallic framework of distal extension RPD fitted in the patient's mouth.*

After mouth preparation was completed, final anatomic impression was made with condensation silicon impression material and poured with extra hard dental stone to produce master cast. The master cast was modified and duplicated into investment material. Wax pattern of RPD design was constructed on the duplicated cast then sprued, invested and cast in casting machine. The finished metal framework was then fitted in the patient mouth.

The maxillary denture positive replica was oriented and mounted on semi-adjustable articulator using remount jig. Mandibular cast was mounted according to vertical and horizontal jaw relation records. Non-anatomic acrylic resin artificial teeth were arranged for lingualized balanced occlusion then tried in the patient mouth before processing and finishing of mandibular definitive RPD.

Healing abutments were removed and the randomly selected individual attachments were screwed in each implant. Patients were equally and randomly divided into two groups as follows:

- **Group I:** Where patients received maxillary complete denture opposed by mandibular distally extended RPD retained posteriorly by implant and ball attachment.
- **Group II:** Where patients received maxillary complete denture opposed by mandibular distally extended RPD retained posteriorly by implant and OT-equator attachment (Figure 3).

Figure 3: *Mandibular bilateral free end saddle with OT-equators and dental implants located at 1st molar area bilaterally.*

The fitting surface of the removable partial denture base was recessed to receive female housing of the attachment. Small vent holes were perforated in the lingual flanges adjacent to the prepared cavities to allow escape of excess autopolymerized acrylic resin during pick up the attachment directly.

Before attachment pick up procedure, the denture base adaptation to the underlying ridge was confirmed by using thin mix alginate and seating through three-point finger pressure on the occlusal rests and major connector. Direct pick-up of the attachment was performed while the mouth was closing in maximum intercuspation till polymerization partially occurred. The prosthesis was removed and left in warm water till polymerization was completed (Figure 4). Pick up material was checked for voids or defects and any excess was removed using round burs.

Figure 4: *Fitting surface of the distal extension RPD after attachment pick up.*

The crestal bone height was measured around the primary abutment teeth (1st premolars) supporting IARPOD then the mean of alveolar bone loss was calculated at every 3-month interval (T0-T3), (T3-T6), (T6-T9) and at 9-month interval (T0-T9). Bone height changes were measured at four points around the tooth; buccally, lingually, mesially, and distally using cone beam volumetric CT images then the average value was calculated and recorded.

Statistical analysis

The data were analyzed using SPSS® software version 22 (SPSS Inc., Chicago, IL, USA). One-Sample Kolmogorov-Smirnov and Shapiro Wilk tests were used to diagnose normality of data distribution of all variables. The data were parametric and presented as mean ± SD. Between-group comparisons of VBL and HBLO was performed using independent t-test. To detect significant differences between times intervals, repeated measures ANOVA was used followed by Bonferroni test for multiple comparison. P-values < 0.05 were considered to be significant.

Results

Comparing the 1st two intervals (T0-T3) and (T3-T6), there was a significant difference (p value = 0.007 and 0.49 respectively) in mean abutment alveolar bone loss between the two groups where group II showed significant higher bone loss (0.42 mm ± 0.6 mm) and (0.35 mm ± 0.11 mm) than the ball attachment (0.35 mm ± 0.06 mm) and (0.25 mm ± 0.12 mm) (Table 1 and 2). However; the difference in mean abutment alveolar bone loss between both groups in the third interval (T6-T9) has increased (0.000) in comparison to the first two intervals (T0-T3) and (T3-T6) where the mean alveolar bone loss around abutment teeth was higher for group II (0.23 mm ± 0.07 mm) (Table 3).

	Mean	Standard deviation	t	Independent samples -t test (p value)
Group A	.3542	.06007	-2.951	.007*
Group B	.4272	.06110		

Table 1: *Comparison of bone loss between groups at first 3-month interval (T0-T3).*

** p is significant at 5%*

	Mean	Standard deviation	t	Independent samples -t test (p value)
Group A	.2542	.12041	-2.043	.049*
Group B	.3531	.11676		

Table 2: *Comparison of bone loss between groups at second 3-month interval (T3-T6).*

** p is significant at 5%*

	Mean	Standard deviation	t	Independent samples -t test (p value)
Group A	.1250	.02908	-4.431	.000*
Group B	.2335	.07967		

Table 3: *Comparison of bone loss between groups at third 3-month interval (T6-T9).*

** p is significant at 5%*

In the total time interval (T0-T9) there was a significant difference (P value = 0.008) in the mean abutment alveolar bone loss after 9 months from the baseline between both groups (Table 4).

	Mean	Standard deviation	t	Independent samples -t test (p value)
Group A	.7292	.15335	-.935	0.008
Group B	.101	.11001		

Table 4: *Comparison of bone loss between groups after 9-month interval from the baseline (T0-T9).*

P is significant at 5%

Discussion

Selection of the attaching mechanism for an implant-retained removable prosthesis should consider the following: cost effectiveness, amount of retention needed, pain caused on the soft tissue, amount of available bone, expected level of oral hygiene, patient's social status, patient's expectation, maxillomandibular relationship, status of the antagonistic jaw, and inter-implant distance [12].

On comparing the ball attachment to OT-equator attachment, the latter offers more advantageous features. Titanium Nitride (TiN) coating provides maximum resistance to wear, also a small-scale metal housing and replaceable nylon caps, offering various retention levels. Retention caps can be replaced easily within seconds. This form of attachment has the minimum vertical height and diameter for the overdenture abutment available in the market with 1.7 mm height and 2.5 mm diameter [10].

In the present study, the mean crestal bone loss around each abutment tooth was calculated by measuring bone height around the mesial, distal, buccal and lingual surfaces of each tooth and divided by 4 and then the mean abutment bone height was calculated for every patient and finally for all patients in each group.

In group A, the mean bone height around abutment teeth decreased gradually with advance of time and between intervals. The mean crestal bone loss around abutment teeth was (±0.35 mm) after the 1st three months and decreased gradually (±0.25 mm) during the 2nd three months to record the minimal value during the 3rd three months (±0.12 mm). In group B, the mean bone height around abutment teeth also decreased gradually with advance of time. The mean crestal bone loss around abutment teeth was (±0.43 mm) after the 1st 3 months and decreased gradually (±0.35 mm) during the 2nd three months to record the minimal value during the 3rd three months (±0.23 mm).

The gradual decrease in crestal bone loss around the abutment teeth may be attributed to the gradual denture base settlement during the first few months; this may result in less movement of the denture base with time which contributes to more resistance to the rotational and lateral movements and so less stresses on abutment teeth and less bone resorption [13].

In the first as well as the second three months from RPD insertion and connecting the attachments, the mean abutment crestal bone loss was higher in OT-equator attachment than the ball attachment, the mean abutment crestal bone loss was (0.35 mm, 0.25 mm) and (0.42 mm, 0.35 mm) respectively. This may explain that OT-equator attachment allow more vertical and lateral movements of the prosthesis with low resistance to the forces applied to bilateral free end saddle RPD. In addition to the multidirectional rotational movement that occur to the DERPD under functional loading which generates greater potential damage for the periodontal tissues of the abutment tooth.

This explanation is in accordance with ELsyad., *et al.* who reported in their invitro study that the "resilient" configuration allows for more movements of the denture therefore, more stresses will be applied on the abutment teeth [14]. Also the present findings coincides with Alquitbay., *et al.* who concluded that resilient implant attachments reduced strains around the implant site allowing the abutment teeth to share strains with the implant [8].

On the contrary, Mahrous., *et al.* [15] concluded that there was insignificant difference in the mean abutment alveolar bone resorption between a resilient low profile attachment and the ball attachment after 6 months which not be found in the present study. This conflicting results may be due to using RPI clasp in their study that can transmit less stresses to the abutment teeth as concluded by Abd-Elkhalek., *et al* [16]. The effect of opposing arch and the occlusal scheme may be of a concern in each study.

The mean crestal bone loss around abutment teeth in OT-equator attachment was higher when compared to ball attachment. SEM analysis confirmed that wear rate depends primarily on contact area and is directly proportional to it. This may explain that female parts of the OT–equator attachment was subjected to wear greater than the retentive female caps of the attachments as a result of greater denture base movement [17]. This explanation is in agreement with Wolf et al. who reported that the ball attachment provided better retention and better resistance to wear on the long term in comparison to resilient attachments [18].

Wear and retention loss seems to allow more movement of the denture base which will direct more forces towards the abutment teeth and eventually more resorption around the abutment teeth [17]. Therefore, the mean abutment crestal bone resorption in the OT-equator attachment was higher than that in ball attachment at the end of the study.

Because the occluso-gingival height of the attachment may influence the biomechanics of the prosthesis, many authors reported that low profile attachment with small diameter help in decreasing stresses on implant abutment and directing more forces toward tooth abutments supporting RPD [19-21]. However, in another in vitro study that used ball attachments for IADERPOD, the authors found a more decreased strain around abutment teeth for IADEPOD with ball attachments [14].

Conclusion

Within the limitation of the present study, ball attachments used to retain IADEPODs to the implants may be associated with decreased crestal bone resorption around abutment teeth than OT-equator attachment. The use of ball attachment may be the suitable choice for anchoring distally extended removable partial denture to dental implants with improved longevity of the natural tooth abutments particularly when splinting of the abutment teeth are not planned.

Conflict of Interest

No financial interest or any conflict of interest exists.

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