Implant Supported Distal Extension over Denture Retained by Two Types of Attachments. A Comparative Radiographic Study by Cone Beam Computed Tomography
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Abstract:
Background: This study was conducted to compare and evaluate the effect of two different attachments (locator attachment and ball and socket [B&S] attachment) on implants and natural abutments supporting structures, in cases of limited inter-arch spaces in mandibular Kennedy Class I implant supported removable partial over dentures by measuring the bone height changes through the cone beam radiographic technology.

Materials and Methods: Two implants were positioned in the first or second molar area following the two-stage surgical protocol. Two equal groups were divided ten for each: Group I: Sides were the placed implants restored by the locator attachment. Group II: The other sides, implants were restored by B&S attachment. Evaluation of the implants and main abutments supporting structures of each group was done at the time of removable partial over denture insertion, 6, 12 and 18 months by measuring the bone height changes using cone beam computed tomography.

Results: Implants with locator attachment showed marginal bone height better effects on implants and main abutments supporting structures.

Conclusion: Implants restored by locator attachment shows better effects on bone of both main natural abutments and implant than those restored with ball and socket.

Key Words: Implant supported partial over denture, limited inter-arch space, locator attachment

Introduction
Loss of posterior teeth may result in loss of neuromuscular stability of the mandible, reduced masticatory efficiency, loss of vertical dimension of occlusion and attrition of the anterior teeth.1 Kennedy classified those patients suffering from bilateral missing posterior teeth as Kennedy Class I removable partial dentures, which considered a very special and thought-provoking situation.2 The main problem associated with bilateral distal extension base removable partial dentures is support. The problem of support is mainly due to the composite nature of supporting structures, which arises from the loss of the posterior abutment and viscoelastic behavior of the mucosa and periodontal ligament.3

Due to extraction of teeth due to carious lesions without any periodontal diseases or minimal bone loss,4 extraction of the lower teeth without proper or delayed restoration of the edentulous area for long time, which usually cause over eruption of the antagonistic teeth directly affecting the inter-arch space between the upper and lower arches thus directing the treatment plane to cretin types of attachments to avoid the alteration in the occlusal plane and the vertical dimension of occlusion.5

Evaluation of space limitation after implant surgery also allows for the selection of the appropriate attachment.56 Problems such as fractured or over contoured prosthesis may occur because of inappropriate planning. This can result in the need for replacement of the implant over denture attachment, late modification of the treatment plan, or even failure of the definitive prosthesis.6 Hence that a special group of attachments to fit within the available limited inter-arch space was introduced known as the low profile attachments.78 Low profile attachments are special type of dental attachments characterized by low or reduced abutment height in the vertical dimension, to accommodate the narrow or limited space between the dental arches.911 The low profile feature enables the technician to utilize more space for an enhanced esthetic denture set-up. The additional space also provides more room for denture acrylic, which will in turn strengthen the denture.12

One of the recently applied low profile attachments is the locator attachment. It is a Universal hinge, resilient attachment for end osseous implants or natural root abutments, locator abutment has the smallest vertical profile available.13 The standard locator male (white nylon liner) will permit up to 10° of divergence for a single implant and 20° between implants.14 It was found that the relation between the bone resorption around both the dental implant and the used principle abutment is directly affecting the survival and success of the implant supported partial over denture.
Evaluation of the supporting structures and bone height by using the cone-beam computed tomography (CBCT) as it seems to be one of the most advanced and promising resources in this field.15–17

**Aim of this study**

Was to compare and evaluate the effect of two different types of attachments (locator attachment and ball and socket [B&S] attachment) which were used in cases of limited inter-arch space in mandibular Kennedy Class I implant supported removable partial over dentures on the supporting structures through measuring the marginal bone height changes around both implants and main abutments by using the cone beam technology.

**Materials and Methods**

Twenty partially edentulous patients with Kennedy Class I lower partially edentulous ridges with the first or second premolars were the last standing abutments, remaining teeth had good periodontal condition were selected, with no signs of attrition or gingival recession, the remaining residual ridges had enough bone height and width and covered with firm mucosa, showing no signs of inflammation or ulceration, all patients should have inadequate inter-arch space distance as determined by tentative diagnostic jaw relation records, Age of the patients ranged between 30 and 60 years, the maxillary arch was dentulous or partially edentulous that was restored with a fixed restoration, patients had skeletal Angle’s Class I maxillomandibular relationship, had good oral hygiene and low caries index, patients having abnormal habits or parafunctional habits as bruxism or clenching were not included in the study, patients were free from temporomandibular joint disorders and also patients having anemia, nutritional deficiency, under chemo or radiotherapy or hormonal disorders as diabetes, thyroid or parathyroid hormonal diseases were not included. Consent forms were signed by all patients selected for this work before the treatment.

The entire selected patient were informed about the procedure and motivated to the treatment. They agreed to co-operate and follow the instruction. After both laboratory investigations and preoperative intra-oral examinations with radiographic evaluation of each case, a diagnostic casts were obtained surveyed and mounted on a semi-adjustable articulator by intra-oral face-bow record and occlusal record for correction of any occlusal disharmonies and evaluation of the occlusal plane and the limitation of the inter-arch space, Several methods were produced to evaluate the amount of available inter-arch space for both partially or completely edentulous patients for better selection of the attachment of the implant supported overdenture.7 One of those methods is by using a sectioned silicone mold over the area of the anticipated implant position and the selected attachment can be tried – in to fit within the available space.18

Another method is by using a graded periodontal probe or ruler to evaluate inters-arch space over a mounted casts on an articulator.18 We selected to use an endodontic plugger with stopper and a ruler for identifying the limitation in the inter-arch space (Figure 1).

Mouth preparations were carried out and 1:1 magnification pre-surgical panoramic X-ray were done followed by ridge mapping on the diagnostic casts for determination and selection of the implant site, size and diameter. Construction of a transparent acrylic surgical stent was done for instillation of 3.75 mm and 10 mm Pitt Easy V-TPS implant system to be placed at the first-second mandibular molar area of the free end saddle.

After the second stage surgery the placed dental implants were divided and grouped into 2 equal groups according to the attachment for rehabilitation into Group I (locator attachment) and Group II (B&S attachment). The partial over denture metal framework design for all the cases was the same as using RPI as a direct retainer and the lingual bar as a major connector and an auxiliary rest on the second abutment as indirect retention.

Final impression was done using medium body consistency rubber base impression material and master cast was obtained and then duplicated to obtain the refractory cast for metal framework casting, try in was carried out for any occlusal adjustment followed by setting of the artificial cross linked acrylic artificial teeth and denture processing and the removable partial over denture is then finished and polished.

**For Group I (locator attachment)**

Placement of the locator attachment intraorally over the integrated implant using the locator tool, fixing the locator female housing into the fitting surface of the removable partial over denture was carried out using the pick-up technique and placing and securing the over denture in its position until the acrylic resin is set followed by finishing and polishing of the over denture and placement of the selected nylon cap. Into locator attachment female housing (Figure 2).

**Figure 1:** Mounted casts on articulator for identifying the inter-arch space.
For Group II (B&S)
The same procedures were carried out for fixing the attachment female part in the removable partial over denture fitting surface (Figure 3).

The finished removable partial over denture for both groups were inserted and delivered to the patients after occlusal adjustment for radiographic evaluation after 6, 12 and 18 months.

Radiographic evaluation
Evaluation of the marginal bone level around both the implants and the main abutment using the linear measurement system supplied by the -CBCT (K.V.P.85, M.A.16, Field of view 7 cm × 14.5 cm × 14.5 cm) this was done after 6, 12 and 18 months post-insertion.

Image analysis
The marginal bone height around the distal, buccal and lingual surfaces of the anterior natural abutments and the mesial, distal, buccal and lingual surfaces of the posterior implants were evaluated for both groups (locator attachment and B&S attachment), using the linear measurement system of the software (Ondemand 3D) with flat panel detector supplied by the CBCT.

From the sagittal plane, distal marginal bone height around natural abutments and mesial and distal marginal bone height around posterior implants could be evaluated. First a line was drawn horizontally tangential to the apex of the tooth and perpendicular to its long axis. Three lines were then drawn tangential to the distal surface of the tooth, parallel to each other and extended from the highest level of the alveolar crest to the horizontal line. The same is done for the frontal plane.

For each plane lengths of three lines was obtained and divided by three to obtain the average of bone height. The procedure was repeated for the lingual surfaces of other abutments and for the implants (Figures 4 and 5).

The measurements were carried out at (6, 12 months and 18 months post insertion). The marginal bone changes at different intervals were obtained by calculating the difference in bone height at that interval from the base line measurement.

Figure 2: Evaluation of inter arch space after locator attachment placement.

Figure 3: Placed ball and socket attachment male potion intraorally.

Figure 4: Mesial and distal marginal boneheight measurments around implants.

Figure 5: Buccal and lingual marginal bone height measurements around the main abutment.
**Statistical analysis**

Statistical analysis of the results was done with the analysis of variance followed by Bonferroni multiple comparison test within subgroups for parametric variables. Chi-square test for non-parametric variables were made.

Statistical analysis was performed using software Graphpad prism-4 statistic for windows. \( P < 0.05 \) are considered to be statistically significant in all tests.

**Results**

**Around implant**

Bone height results for both attachment groups around implant at the different intervals of the follow-up period are summarized in Table 1.

Group I (locator) versus Group II (B&S): Comparison of the mean percentage changes of bone loss showed that locator group recorded statistically significant lower bone loss than B&S group at the different intervals of the follow-up period \( (P < 0.05) \) (Graph 1).

**Around the main abutment**

locator versus B&S group: Comparison of the mean percentage changes of bone loss showed that locator group recorded statistically significant lower bone loss than B&S group at 12 m and 18 m intervals of the follow-up period \( (P < 0.05) \) while non-significant after 6 m \( (P > 0.05) \) (Graph 2).

**Discussion**

Kennedy Class I partially edentulous patients were selected in this study because this category represents the most frequently partially edentulous cases, also most of the problems are present in such cases due to nature of the mucosa that provides different support to the denture and limited denture bearing area for the partial denture.\(^9\)

Determination of the inter-arch limitation was achieved through mounting the upper and lower casts on an articulator.\(^8\) The opposing arch was either dentulous or partially edentulous that was restored with fixed restoration, to standardize the amount of occlusal forces transmitted to the lower arch, since the type of opposing occlusion is among the important factors that influence the magnitude of forces transmitted to the lower arch.

Two distally positioned implants in the area of the first or second molars would effectively transform the Kennedy Class I configuration into a more favorable Kennedy Class III. In this study the dental implants were placed distally in the first or second molar area. Theoretically, the implants should be located as distally as possible to provide maximum support.\(^20,21\)

For Group I the selection of the attachment was based on the attachment height to fit in the limited inter-arch space between the upper and lower arches. With high resiliency, for better forces distribution over the dental implant and for increasing the support in general for the mandibular removable partial overdenture.\(^22,23\) One of the low profile attachments that can be used in some cases of reduced and limited inter arch space.\(^24,25,15\) For Group II (rehabilitated

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**Table 1:** Comparisons of bone height change for both attachment groups around implant from the baseline values at the different intervals of the follow-up period.

| Attachment | Variable | 6 m-BL | 12 m-BL | 18 m-BL |
|------------|----------|--------|---------|---------|
| Locator    | Bone loss| −0.63  | −1.062  | −1.23   |
|            | Mean % change | −6.86649 | −11.5749 | −13.406 |
|            | Paired t value | 15.6 | 14.6 | 16.2 |
|            | P value | 0.0006* | 0.0007* | 0.0005* |
| B&S        | Bone loss | −1.225 | −2.005 | −2.177 |
|            | Mean % change | −15.5952 | −25.5251 | −27.7148 |
|            | Paired t value | 4.9 | 9.1 | 10.9 |
|            | P value | 0.0165* | 0.0028* | 0.0017* |

*Significant (\( P<0.05 \)) ns: Non-significant (\( P>0.05 \)). Statistical analysis of the mean percentage change in bone loss from the baseline value (time of denture insertion) for locator group revealed significant difference at the different intervals of the follow-up period (\( P<0.05 \)).

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**Graph 1:** A column chart of the mean values of bone loss in both groups around implant at the different intervals of the follow-up period.

**Graph 2:** A linear curve of the mean values of bone loss in both groups around abutment at the different intervals of the follow-up period.
with B&S attachment) the selection of the attachment was based on that the B&S attachment is one of the most commonly used dental attachment with implant supported partial over dentures, as the attachment is considered.

Evaluation of the bone height was done by using the CBCT as it seems to be one of the most advanced and promising resources in this field. CBCT was used in the field of dentomaxillofacial radiology CBCT imaging, CBCT offers a promising alternative approach since it provides sub-millimeter resolution images of high diagnostic quality, with short scanning time and reduced radiation dose up to 15 times lower than multi-slice CT scans (MSCT).

**Discussion of Results**

Regarding the crestal bone loss around the implant, the results for the two groups showed that a significant amount of bone loss around the implant after 18 months follow up of denture insertion. The amount of peri-implant bone loss agrees with the findings obtained by Albrektsson et al., who proposed criteria for implant survival and success, in which marginal bone level changes in the 1st year should be <1-1.5 mm, and ongoing annual bone loss should be <0.2 mm. Using the Branemark System, Adell et al. reported a bone loss of 1.2 mm for the 1st year in their 15 years study. It was suggested that the initial marginal bone level change occurred as an adaptation of the peri-implant bone to the occlusal load. Numerous studies that had investigated the marginal bone loss that occurs around Branemark implants after the 1st year of service found a range from 0.4 to 1.6 mm. This crestal bone loss may be due to the periosteal reflection, implant osteotomy and the stress factors from bone strain at the implant insertion and stresses applied by the prosthesis.

Comparison of the mean percentage changes of bone loss around the dental implants showed that Group I (locator attachment) recorded statistically significant lower bone loss than Group II (B&S attachment) at the different intervals of the follow-up period (P < 0.05). That was found to be in agreement with a study carried out by Schneider, who recommended the use of locator attachment in implant supported removable partial dentures as a resilient attachment for better force distribution. Also, this study was in agreement with Chikunov et al. in a study that showed the locator attachment is recommended as a resilient attachment and correcting the divergence between the placed dental implants carrying an over denture.

Comparison of the mean percentage changes of bone loss around the main abutments showed that Group I (locator attachment) recorded statistically significant lower bone loss than Group II (B&S attachment) at 12 m and 18 m intervals of the follow-up period (P < 0.05) while non-significant after 6 m (P > 0.05). This is because that the locator attachment has better force distribution over the edentulous ridge and the main abutments due to its resiliency which is higher than that of the ball & socket attachment and that was in agreement with Kratochvil et al., whom examined three types of attachment, resilient, semi precision and rigid-precision attachments, and they reported that the resilient attachment produced the most force on the edentulous regions and the least force on the abutment teeth. And also was in agreement with the study done by Chikunov et al. that showed the locator attachment has a better effect on the abutment teeth as a resilient attachment than other resilient attachments did.

The result of this study was in agreement with Fu et al. who reported that dental implants with attachment designs incorporated into removable partial denture can improve denture retention, stability, and support, as they reduces the stresses applied on the abutment teeth and eliminate the need for un-esthetic clasp. And also this was found to be in agreement with Siato et al. that showed that using rigid attachments tend to concentrate more stresses at the terminal abutment teeth.

**Conclusion**

Within the limitation of the results of this study, it could be concluded that: The side of the implant-supported partial over denture restored with the locator attachment showed better effect on bone health around both the placed dental implant and the main natural abutment as compared with the other side of the implant supported partial over denture with the B&S attachment.

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