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Original Article

The Effect of Locator Attachment and Ball-O-Ring Attachment on Bone Height Change in Implant Retained Overdenture

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ABSTRACT

Objectives. *This study was conducted to evaluate and compare the effect of locator attachment and Ball-O-ring attachment on the peri-implant crestal bone level changes in edentulous patients rehabilitated with implant retained lower over denture.* ***Methods.*** *Twenty edentulous patients (male) were participating in this study, they were rehabilitated by mucosa supported maxillary complete denture and implant retained mandibular over denture by two implants installed in the canine region, patients were divided into two equal groups according to the type of attachment used, the locator attachment was used for group I and Ball-O-ring attachment was used for group II. Peri-implant crestal bone level changes were assessed using intra-oral radiographs taken with the standardized long cone paralleling technique using custom made acrylic template and the Rinn-xcp system. Periapical radiographs were taken every six months to complete a period of 18 months follow up period. The marginal bone loss at different intervals was obtained by calculating the difference in bone height at that interval from the base line measurement and statistically analyzed (t-test $P < 0.05$).* ***Results.*** *The result of this study showed that the time has significant effect on the mean values of the peri-implant bone height on both groups. Moreover, group I had significantly less bone resorption from insertion to twelve months in compare to group II.* ***Conclusion.*** *The insignificant difference observed between comparing the peri-implant bone loss between the two groups indicates that the two treatment modalities are effective for the rehabilitation of lower denture. Locator attachments have the ability to control the amount bone loss. It could be advantageous in cases where the retention of implants retained overdentures is compromised.*

Keywords*: Locator, Ball-O-Ring, Bone, Implant, Overdenture.*

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INTRODUCTION

Nowadays, the use two implant supported and retained lower overdenture has been considered an appropriate treatment of choice and has increasingly become a routine option for rehabilitation of patients with inadequate bone volume in the posterior part of the mandible [1,2].

Numerous studies have shown that the mandibular two-implant overdenture is a simple and effective solution and leads to significant improvement of patient-based outcomes as compared to conventional dentures. Preservation of the residual ridges, tactile discrimination, improvement of masticatory performance, retention and stability, maintaining occlusion and vertical dimension have been reported in the literature [3-7].

The most commonly used attachment systems for implant retained overdenture are balls and bars. Ball

attachments as prefabricated, unsplinted units are easily replaceable and show hygienic advantages, while bars are used to splint the implants and provide favorable stability [8,9].

In one ball attachment system known as the O-ring attachment, a plastic ring is fitted in a groove inside a metal ring or socket, which is housed in the fitting surface of the denture [10].

Ball-O-ring attachments have been widely used because of their low price, ease of replacement, and minimal chair time required. Their abutments are available in different designs and sizes, with gingival cuffs of varying lengths. The height of the abutment cuff is dependent on the thickness of the soft tissue. The O-ring abutment must be placed about 1 mm supra-gingivally [11].

Advantages of Ball attachment system include ease of maintenance of hygiene around the implant, low cost, minimal chair-side time and ease of replacement of elements if required [11,12]. However, one of the major disadvantages is that the ball violates the vertical restorative space because of its high profile as the patrix is standing over the edentulous ridge. As with most other attachment systems, the ball system loses retention by wear of the matrices and patrices. Ball attachments are not suitable to use when the implants are not parallel (an angulation >15°) as retention is reduced significantly. Ball attachments make for easier hygiene and fewer technical complications than bar- splinted ones [13-15].

The locator is a newer clinical alternative to the established ball attachments used for implant retained overdenture. A characteristic feature of locator attachment is the unique dual retention with combined internal and external retentive features. This provides a greater retention surface area than other types of attachments [16,17]. The locator abutment insert is provided with different degrees of resiliency enhancing its benefit and acceptance among dental patients [11,12].

The locator system has a low vertical height compared to other systems allowing its use in restricted vertical space. A reported minimum space requirement for implant supported overdentures with locator attachments is 8.5 mm vertical space. A minimum of 13-14 mm of vertical space is required for bar supported overdentures, and 10-12mm for overdentures supported by individual attachments [18-20].

The self-aligning design allows for the patrix and matrix to attach together without precise alignment, which makes the connection easier by the patient. This rotational pivoting action allows a resilient connection for the prosthesis, this feature reduces the amount of retention loss. The nylon remains in contact with the abutment while the metal cap moves over the nylons. The clear, pink and blue can compensate for up to 10 of divergence from vertical 20 between implants while the green and red inserts can be used for up to 20 of divergence from vertical 40 between implants. The internal extension is absent from the green and red insert to compensate for the angulation [19,21].

Monitoring marginal bone loss around implants is regarded by numerous authors as the most important criterion in determining the success of implants [22-25]. This criterion is generally accepted as a reliable indicator of bone response to the surgical procedure and subsequent occlusal loading. Accordingly, this study was conducted to evaluate and compare the effect of Ball-O-ring attachments and locator attachment on the peri-implant crestal bone level changes in edentulous patients rehabilitated with implant retained over denture

METHODS

Twenty male patients exhibiting completely edentulous mandibular and maxillary arch were selected to participate in this study. Age of the selected patients ranged between 60 –70 years. The selected patients exhibited Angle class I ridge relationship, patients had either rounded or U-shaped alveolar arches, adequate inter arch space, no history of parafunctional habits, they also had no temporomandibular joint disorders. The residual alveolar ridge exhibited adequate height and width and was covered with firm fibrous mucoperiosteum.

All patients were in a good acceptable general health, with no psychological disorders or neuromuscular incoordination. All patients participating in this study were rehabilitated by mucosa supported maxillary complete denture and implant retained mandibular over denture by two implants installed in the canine region and retained by locator attachment.

Detailed information about the treatment was given to all the patients; the surgical and prosthetic steps, the risks and the benefits were explained All the patients were motivated to the treatment and were informed that they will be a part in a study that needs their best co-operation. All the patients agreed to share and follow the recommendations and instructions given to them in the form of signed consent.

Provisional jaw relation record was made at the predetermined occlusal vertical dimension. The maxillary and mandibular casts were mounted on a "Mean value articulator" to ensure parallelism between the upper and lower ridges, Angle's class I skeletal maxillomandibular relationship and the presence of at least 15mm restorative space. Radiographic stent was fabricated by duplication of patient's lower denture into transparent heat-cured acrylic resin. Pre-operative CBCT (Cone Beam CT) was carried out for all patients with gutta percha placed on the patient old denture at the canine position to evaluate bone height, width and density in the proposed implant sites.

Upper and Lower complete dentures were constructed to all the patients following the same basic principles. Centric occlusion was developed at centric relation. Modified cusped acrylic teeth were used and balanced on semi-adjustable articulator for centric and eccentric positions following the lingualized concept of occlusion. Dentures were clinically remounted to refine the occlusion, to ensure free anterior contact in centric and free non-interfering contact during all excursive mandibular movements.

For all the selected patients two implants 3.75 mm in diameter and 14 mm in length were installed in the canine area following the two-stage surgical technique. Following the routine surgical procedure, implant fixture was positioned with the help of the modified transparent acrylic template. A functional healing period was allowed to progress for four months, through which the patients were wearing their dentures lined by tissue conditioning material.

The cover screws were unthreaded and the conical healing abutments were screwed in position. The fitting surface of the mandibular denture was relieved opposite to the implants' sites and tried in the patient's mouth until the denture was seated comfortably. Patients participating in this study were randomly divided into two equal groups according to the type of attachment used. One week later, the healing abutments were replaced and by the locator abutments for group I patients Fig. (1) and Ball-O-ring attachments for group II patients.

For group I patients' areas in the denture corresponding to the two inserted locator abutments group I were relieved to create enough space to accommodate the abutment. The denture was tried in the patient's mouth to ensure complete seating. A white spacer ring was fitted over the head of each abutment to protect the sub-housing area from acrylic flow and the housing was placed in position and self-cured acrylic resin was used to directly pick up the attachment following the conventional technique. Patients were instructed to close in centric until complete polymerization took place. The denture was then left for bench curing, Excess material was trimmed out and the fitting surface over abutments was relieved to eliminate any contact except at the top of the abutments. The black processing male was removed from the metal housing and replaced by the transparent nylon replacement insert (fig. 2).

Fig (1): Locator abutment in position

Fig (2): Black male in the fitting surface of denture

While for group II, the healing abutments were replaced by the Ball-O-ring attachments. The tissue surface of the over denture opposite to the implant was relieved, metal housings were positioned over the abutments and self-cured acrylic resin was used to directly pick up the attachment following the conventional technique. The female metal housings were fixed on the ball attachment and the denture was positioned back in place to assure complete seating and complete relief around the balls and the housings. Any additional adjustments needed were done. Peri-implant crestal bone level changes were assessed using intra-oral radiographs taken with the standardized long cone paralleling technique using custom made acrylic template and the Rinn-xcp system [26].

After performing the needed post insertion adjustment, periapical radiographs were taken every six months to complete a period of 1.5 year follow up period. A piece of wire was embedded in the acrylic template was used as a reference point to assess marginal bone height changes at the mesial and distal aspect of each implant using digora software system. Each time patients were recalled; dentures were evaluated and occlusal adjustment was performed.

RESULTS

The results of this study are shown in tables (1-3) and figures. Testing for significance between means within each group was performed by the paired t-test for. The mean values for group I and group II were compared by the student t-test; a probability level (p) of 0.05 or less was chosen as the level of significant difference. All patients attended the follow up recall visits. The implants bearing locator attachment (Group I) and implants bearing Ball-O-ring attachments (Group II) showed successful clinical osseointegration till the end of follow up period. Patients expressed satisfaction as regards function retention and stability of their appliances. Clinically, no pain was elicited with palpation or percussion, no exudates was observed in relation to the implants

Table 1, represents the mean values of the peri-implant bone height changes for group I throughout the study period (patients rehabilitated with implants retained lower overdentures by locator attachment). The calculated mean difference was found to be 0.469, -0.697, and 0.767. at six, twelve and eighteen months after denture insertion respectively. Statistical analysis of the data revealed statistically significant $P \leq 0.05$ during the study period.

Regarding group II patients (Ball-O-ring attachments), the mean difference, standard deviation (SD) and results of paired t-test for crestal bone height changes by time are presented in table (2). The calculated mean difference was found to be -0.489, -0.784, and 0.-864 at six, twelve and eighteen months after denture insertion respectively. Statistical analysis of the data revealed statistically significant $P \leq 0.05$ during the study period.

Table (1): Mean difference values, standard deviation (SD) values and results of paired t-test for crestal bone height changes by time within Group (1) patients during the follow-up period.

Period	Mean difference	SD	*P-value*
Base line – 6 months	- 0.469	0.03	*<0.001**
Base line – 12 months	- 0.697	0.06	*<0.001**
Base line – 18 months	*- 0.767*	*0.04*	*<0.001**

** Significant at P ≤ 0.05*

Table (2): Mean difference values, standard deviation (SD) values and results of paired t-test for crestal bone height changes by time within Group (2) patients during the follow-up period

Period	Mean difference	SD	P-value
Base line – 6 months	- 0.489	0.04	<0.001*
Base line – 12 months	- 0.784	0.05	<0.001*
Base line – 18 months	- 0.864	0.04	<0.001*

** Significant at P ≤ 0.05*

Comparing crestal bone height loss between the two groups, the results showed that there was a continuous increase in crestal bone height loss throughout the study in both groups as shown in table

3. Although mean values in Group (2) 0.489, 0.784, and 0.864 were higher than those in Group (1) 0.469, -0.697, and 0.767 at 0, 6, 12 and 18 months respectively, there was no statistically significant difference between the two groups throughout the study period.

Table (3): Mean values, standard deviation (SD) and results of Student's t-test for comparison between bone height of the two groups during the follow-up period

Group Period	Group 1		Group 2		*P-value*
	Mean	SD	Mean	SD	
0-6 months	0.469	0.03	*0.489*	0.04	*0.510*
0-12 months	0.697	0.06	*0.784*	0.05	*0.182*
0-18 months	*0.767*	*0.04*	*0.864*	*0.04*	*0.183*

DISCUSSION

The implant –retained overdenture is a combined implant- retained and tissue supported restoration is indicated in compromised cases with fewer implants. Tissue supported overdenture stabilized by two implants are often the restoration of choice due to patient preference, limitation in finance, insufficient available bone to accommodate a greater number of implants or needed improvements in stability, retention, aesthetics and phonetics. This current study evaluated the effect of locator attachment (Group I) and Ball-O-ring attachments (Group IIs in implant retained mandibular overdenture on the implant marginal bone height change.

All criteria for patient's selection were directed to control the adverse effect of systemic and local factors that contraindicate proper osseointegration of implants and avoid excessive load or undue forces on the residual ridge and implants. Standard clinical and laboratory techniques were followed for denture construction for all patients to decrease variables that could affect the results of this study. Cross-linked acrylic resin teeth were balanced following the lingualized concept of occlusion to ensure axial loading of the implants.

The success criteria for the implants are no radiolucency around the implant, no mobility, no suppuration, no pain, and no on-going pathologic process. Also, bone resorption should not exceed 1mm in the first year after implant surgery and loading, where in the following years, a 0.2mm limit should not be exceeded [27]. The results of this current study revealed that the use locator attachment fulfils the criteria of implant success as indicated by clinical examination and the measured amount of bone loss.

Clinically successful osseointegration was assessed throughout the study period by observing signs of inflammation or infection. Mobility was recorded clinically using the handles of two dental mirrors and no degree of implant mobility was detected. Furthermore, to assess implants osseointegration, percussion was performed by tapping each implant with an instrument handle. A solid ringing sound indicated direct bone to implant contact, proper osseointegration and absence of fibrous tissue. This was necessary to clinical evaluate horizontal stability which reflects the condition of the bone-implant interface.

At the end of 18 months follow-up period, a statistically significant decrease in peri-implant bone height for the two studied groups was detected. This amount of bone loss fully complies with success criteria mentioned by Cox and Zarb [27], and Albrektsson [22] et al., and were within the permissible range previously reported to occur within the first year of implant placement.

This bone loss could be based on the hypothesis that marginal bone loss is the result of micro-damage accumulation occurring in bone after implant placement. It was also explained as an early manifestation of wound healing which occurs after implant placement and as a reaction to loading. Crestal bone loss could also be explained by the finding that forces applied on implants are distributed on the crestal bone rather than along the entire implant/bone interface [28,29]. The acceptable range of crestal bone height loss for the two groups until the end of the study period may be attributed to proper selection of cases, adequate implant length in proportion to the height of the residual alveolar ridge,

proper oral hygiene measures, proper implant installations and angulations. It has been observed that the maximum calculated mean of marginal bone loss for both groups was evident at the six-month interval and progressed slowly thereafter.

According to Cochran et al. [30], peri-implant bone remodeling after implant placement is more accentuated in the first six months after surgery and progressed slowly thereafter. The authors found 86% of the bone loss to take place in the first six months after loading in 596 implants assessed for five years.

This marginal bone loss could be based on micro-damage accumulation occurring in bone after implant placement. It was also explained not only as an early manifestation of wound healing which occurs after implant placement but also as a reaction to loading [31]. Crestal bone loss could also be explained by the finding that forces applied on implants are distributed on the crestal bone rather than along the entire implant/bone interface. The results of this study showed that the use of locator attachment showed less amount of the peri-implant bone height loss throughout the follow up period compared Ball-O-ring attachments.

A three-dimensional finite element study comparing the stresses induced by ball and locator attachment considered, the locator attachment advantageous biologically and mechanically as it reduced the stress on the implant body and supporting structures under oblique and vertical loading compared to ball attachment [32] which can account for the results of this study.

The locator male pivots in its permanent metal housing for a resilient connection of the prosthesis. The retentive male remains in static contact with the female socket while its metal housing has a full range of rotational movement. This patent design of pivoting locator male allows a resilient connection for the overdenture without any loss of retention during mastication. Movement is possible in both the vertical plane and the hinge axis through a space of 0.2mm created to allow for vertical resiliency and hinging in any direction [18-20,31].

The locator attachment features a combination of dual retention, it is also characterized by low profile design, and a resilient connection for the overdenture without any loss of retention during mastication can explain this finding. In addition, movement is provided in both the vertical plane and the hinge axis through a space of 0.2mm created to allow for vertical resiliency and hinging in any direction [32] can explain this finding.

Disclaimer

The article has not been previously presented or published, and is not part of a thesis project.

Conflict of interest

We declare that they have no competing interests.

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