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Original Research Article

Comparing Effects of Two Types of Attachments on Mandibular Overdenture Abutments Crestal Bone Height

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ABSTRACT

Comparing the effect of two different types of attachments on mandibular overdenture abutments crestal bone height were studied and compared in twenty completely edentulous patients retaining their two remaining mandibular canines. Patients were randomly divided into two groups. Group I received magnetic attachment mandibular overdenture. Group II received ball and socket attachments mandibular overdenture, both groups, the mandibular overdentures opposed by conventional maxillary complete dentures. The results of this study showed no significant effect on bone height in both groups. Based on the results of the present study, it may be concluded that the use of magnet attachments may be valuable to solve a situation pushing the dentist to override the benefits of its use to prevent the dangerous effects of its horizontal stresses that may be transmitted to the overdenture abutments.

Keywords: Attachment, Mandibular Overdenture, Crestal Bone Height

Comparing the effect of two different types of attachments on mandibular overdenture abutments crestal bone height were studied and compared in twenty completely edentulous patients retaining their two remaining mandibular canines. Patients were randomly divided into two groups. Group I received magnetic attachment mandibular overdenture. Group II received ball and socket attachments mandibular overdenture, both groups, the mandibular overdentures opposed by conventional maxillary complete dentures. The results of this study showed no significant effect on bone height in both groups. Based on the results of the present study, it may be concluded that the use of magnet attachments may be valuable to solve a situation pushing the dentist to override the benefits of its use to prevent the dangerous effects of its horizontal stresses that may be transmitted to the overdenture abutments.

Rehabilitation of patient with few remaining natural teeth with overdenture had received a wide spread application in dentistry due to its several advantages as decreases the progressive resorption of the residual alveolar ridge. Retention of mandibular canines helps in preserve the edentulous ridge. The mechanism of alveolar ridge maintenance through root retention occurs because of the root's ability to express the compressive force to the denture bearing into tensile force to the bone via periodontal ligament [(1,2-11)].

Overdenture attachments can be classified according to their design into telescope attachments, single attachments, bar attachments and auxiliary attachments [12].

Single attachments are subdivided into attachments anchored directly in the root canals without copings (Dalbo-Rotex system) and attachments combined with copings ("stud attachments") [13].

The stud attachments may be resilient attachment or non resilient attachment. Resilient studs perform a compensatory function and act as a safety valve for any overload situation. While non resilient stud attachments are effective when interocclusal space is limited, they are essential when the teeth are stable or when the dentist does not desire movement of the overdenture[14].

The resilient stud attachment reduces vertical and lateral forces on the abutment by distributing more of masticatory load to the tissues. It can be used for tissue-tooth supported appliances with very weak abutments, when there are only few abutments and when maximum tissue support is required. It can be used when the overdenture is opposed by natural dentition.[15].

The o-ring coping attachment serves as a substitute for the conventional prosthetic crown or a precision attachment. The male is made of titanium and the female rubber o-ring is retained in a male retainer ring. The accurate placement of the attachment in the overdenture is critical for the success of the prosthesis. The o-ring coping attachments transmit the occlusal forces in the direction of the abutment long axis and distribute the occlusal loads evenly to the supporting structures [16].

Typical of ball and socket stud attachment is the Dalla Bona 604 or Dalbo 604, which allows for a certain movement of the denture. It is an example of an attachment that is placed on the root. This attachment consists of two components, solder base with a sphere (the male unit) That allows rotational movement, a spacing ring that provides for 0.4 mm vertical movement and an adjustable housing (the female unit) with four lamellae that provide the retention. The lamellae are surrounded by a PVC ring assuring their action. If the attachment is to function without harming the abutment tooth, movement of the denture must be considered [17, 18, 19,20].

Since the mid-1970s, Samarium-cobalt magnets have been used in prosthetic applications and their popularity for use in overdentures has been fast growing since that time [21-23].

Overdenture abutments are compromised teeth; to remain serviceable, even in their new form these teeth must sustain forces of limited magnitude and favorable vector. Magnetic retention is ideal for such teeth. It is self-limiting because the force the magnets exert on supporting roots can not exceed their optimum retention value for vertical displacement. The underlying abutments were subjected to loads mainly in an axial direction, which is well suited to the anatomy of the supporting structures of the teeth[24,25].

Magnets can also slide on their keepers, thus limiting the force transmitted during rocking and rotational denture movements. This later movement can be achieved without loss of retention of the overdenture. This is not the case with mechanical attachments, in which slight construction errors or denture displacement can result in forces on the roots that may be several times greater than their stated retention values [26, 24].

Among the many advantages of samarium cobalt magnets is high coercivity (resistance to demagnetization). Because of this intrinsic property, rare earth magnets maintain their high attractive force indefinitely, and, of equal importance for dental use. They are fabricated in a miniature size that can be easily incorporated into dental restorations [27].

There are no paths of insertion restrictions, and they can be concord self-seating which is an important advantage especially for elderly or arthritic patients [28]. Finally, the magnet is an easily applied and relatively cheap system by which overdentures can be retained, provided that there is enough space for the keepers and magnet units to be accommodated [27].

MATERIALS AND METHODS

Twenty patients having completely edentulous maxillary ridges and partially edentulous mandibular ridges retaining the right and left canines were selected. Patients were thoroughly examined to fulfill certain criteria in order to ensure general and oral condition favorable for carrying out this study, also reduce human variables that may affect the results[29, 30].

The date of last extraction was at least five to six months before treatment to exclude the effect of bone remodeling and high rate of bone resorption that follows extraction on the results of the study [24].

Patients with lower flat or knife edge ridge were not included in this study to increase the amount of support and stability of removable prosthesis. Also to provide maximum tissue support and to minimize movement of the denture base that might create undesirable leverage on the abutment teeth, patients with flabby movable mucoperiosteum were not included [31].

Cases with history of parafunctional habits were excluded to ovoid the effect of abnormal and excessive stresses and the deleterious effects of the resulting lateral forces on the condition of both abutments and bone. Patients with abnormal ridge relation were not included in this study to ovoid abnormal force application on abutments. Also patients with signs of oral pathology or history of periodontal diseases causing extraction of their teeth were excluded from sharing in this study to ovoid the effect of poor bone condition [32].

Patients with adequate interarch space were selected to accommodate the length of the both of magnetic and ball & sockets attachments without encroaching on the vertical dimension of occlusion or altering the position of the occlusal plane [33].

Preparation of the abutment teeth

Thorough periodontal treatment was performed to the abutment teeth to bring the periodontal status of the two bilateral canines to a healthy condition, free from calculus or plaque accumulation in order to establish sound abutments teeth [34].

The root canal was filled with gutta-percha points to ease the root canal preparation and filling removal to the desired root length. Reduction of the crown of the abutments teeth into a dome shape was performed to 2 mm above the gingival margin, resulted in a more favorable crown root ratio that led to the stability of the abutment which assisted in stability of the overdenture [8].

Complete overdenture construction

Complete overdenture was constructed to all the selected patients. Alginate impressions (ALGINOPLUS Via Einaudi 23, 10024 Moncalieri (TO) – ITALY) were made and poured in dental stone to obtain study casts. Border molding was done and secondary impression was made using medium body silicone rubber base impressions material (Colten / Whaledent Inc 235 Ascot parkway, Cuyahoga Falls, Ohio 44223/ USA) using special tray. Face bow record was made to mount the upper cast on semi adjustable articulator. The lower cast was mounted by centric occluding relation record. Protrusive record was made to adjust the horizontal condylar guidance. Setting up of teeth was done using cross-linked acrylic teeth then waxed up, and dentures were then processed. Remounting techniques were carried out to assess and correct any occlusal discrepancy and eliminate the effect of preventive or deflective occlusal contact on overdenture stability. Dentures were delivered and patients were instructed for proper denture and oral hygiene. Patients were frequently recalled for inspection and follow-up.

According to the type of the used attachments, selected patients were randomly divided into two equal groups. Group A: Patients of this group were rehabilitated with mandibular retained overdenture, retained by a closed field magnetic attachment (DYNA MAGNET NS, Korenbeursstraat 26, Netherlands). Group B: Patients of this group were rehabilitated with mandibular retained overdenture, retained by a ball and socket attachments (TUT DENTAL IMPLANTS, Nasr city, Cairo, Egypt).

Placement of magnetic attachment:-

The root canal orifice was prepared to receive the alloy keeper (DYNA EFM Alloy KEEPER, REF3200, SN 2000355. Netherlands) that would be later cemented directly into the patient's abutments.

The prefabricated keeper unit was divided into three parts according to its shape (fig.1). First, the upper top cylinder that would be projecting outside the abutment, to be later attracted to, and form the closed field with the magnet fixed inside the overdenture.

The second and the third parts which are in the form of two diameters serrated post, a larger diameter post to fill the upper part of the root canal and a smaller diameter post to fill the middle of the root canal, and a step is formed between the two post diameters.

The Dyna Company supplies the magnetic attachment system with a drill (fig.1) (DYNA Direct Seat Drill, Stainless steel, REF3241, SN 200070, Netherlands) that is used to prepare the root canal in the same form of the keeper's post.

The preparation to receive the alloy keeper was done in two steps. First, the drill was installed in a low speed contra angle hand piece and inserted in the center of the canal orifice, directed vertically parallel to the long axis of the abutment. The drilling begun at a very low speed in a clock wise direction with irrigation, to prevent clogging of the drill's blades with dentine. The second step was using diamond disc to prepare the top of the abutment flat. The alloy keeper is tried again to check that the flat under surface of the alloy keeper fit exactly above the flat abutment surface. The orifice root canal was dried using air water syringe to eliminate the wetting inside the orifice root canal that could affect the application of the cementation. Adequate glass ionomer cement was mixed properly and then applied into the orifice root canal and the alloy keeper unit was inserted inside the orifice root canal properly and maintained pressure was applied on top of the surface of alloy keeper to allow a correct fixation. After cement had completely set, the excessive cement was removed with dental prope (fig.2). The magnet is in the form of a disc with a rim of metal on its middle circumference (fig.3). The side toward which will be attracted to, and face the alloy keeper is demarcated by a letter V. To prepare a room in the fitting surface of the overdenture, a pressure indicating paste is applied over the alloy keeper surface. The overdenture was seated, the pressure indicating paste was transferred into the fitting surface, noting the exact place to be reduced. This procedure is repeated several times till enough room was made to accept both the alloy keeper with the magnet, and when the patient is closing in centric occlusion with both the upper and lower denture.

Self cure acrylic resin was mixed according to the manufacturer instruction, when reached the dough stage it was applied inside the room made. Meanwhile, the magnet was properly placed over the alloy keeper inside the patient's mouth. The lower denture was inserted properly and the patient was asked to bite in centric occlusion with both the maxillary and mandibular dentures till complete setting of the auto-polymerized acrylic resin.

The excess acrylic resin in the fitting surface and around the magnets was removed (fig.4), and the denture was reseated and the patient was asked to close in centric occluding relation, to make sure of its adaptation.

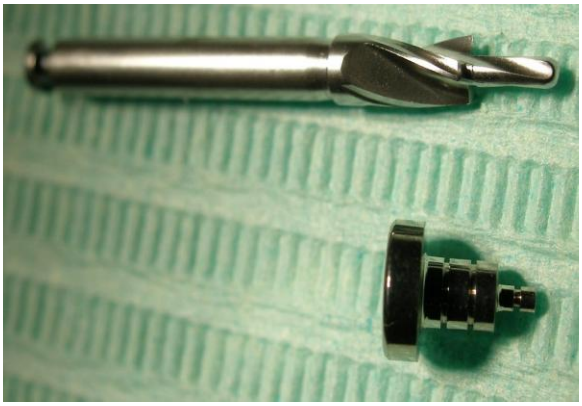

Fig.1 The prefabricated keeper unit and drill

Fig.2 The alloy keeper unit cemented in place.

Fig.3 The Magnet.

Fig.4 The Magnets placed in the fitting surface.

Placement of ball and socket attachment:

The prefabricated titanium ball and socket attachment is formed of male ball part and female socket part (fig.5). The male ball part is divided into three parts according to its shape. The upper ball part that would be projecting outside the abutment, to be later engaged by the socket female part fixed inside the fitting surface of the mandibular overdenture.

The second neck section is in the form cone to be impeded in the coronal section of the abutment. Extending from this cone a 6mm threaded post part to be cemented inside the radicular portion of the abutment root.

The female socket part is divided into a titanium metal containing O-ring. The titanium metal ring inner surface has a concave groove to provide a room for the O-ring. Meanwhile, its outer surface contains grooves to be later placed inside the fitting surface of the mandibular overdenture.

The root canal was prepared to receive the post part of the ball attachment by using a peeso-remmer (Peeso REAMERS RA (CA) 6PCS Stainless steel, Japan) that was placed in the head of low speed hand piece to remove the gutta-percha from the coronal one third of the abutment's root. A parallel sided drill (H.Nordin SA. CH-1816 CHAILLY. Swissland CE 0459) was used to prepare the root canal to receive the post part. The drill was directed vertically parallel to the long axis of the abutment. The drilling was made carefully not to perforate the root canal. The orifice root canal was prepared with egg shaped diamond stone to receive the neck cone part. The neck and post of the ball attachment was tried inside the root canal to evaluate the adaptation of the ball attachment. For cementation of the male part (fig.6), and to prepare a room and attaching the female part into the fitting surface of the overdenture (fig.7), it was done in the same manner as the magnet group.

Fig. 5 The prefabricated titanium ball and socket attachment the male ball part and female socketpart.

Fig. 6 The titanium male ball part cemented in place.

Fig.7 The titanium female socket part in the fitting surface.

Radiographic evaluation of the patients:

Patients were frequently recalled for inspection and post insertion adjustments. The following records were obtained to evaluate the condition of abutments supporting structures at time of denture insertion, three, six, nine and twelve months after denture insertion.

In this study indirect digital radiography was used for imaging and analyzing changes in marginal bone height for its ease of use. The Rin XCP instrument, X-ray machine (Trophy X-ray machine. Made in France), a periapical film, a scanner (Scanner Epson Perfection 1260, China), a Digora system software (Orion corporation. Soredex. Finland), and an individually constructed radiographic acrylic template were used for making standardized digital images for the abutments following the long cone paralleling technique. A D-speed film was used with fixed exposure time and energy for all patients, also automatic processing machine was used to offer a standardized processing system with a great advantage of avoiding variations in the images contrast resulting from manual processing [35].

The Digora system software used to interpret the images after the scanner turned the dental X-ray film into a digital image in a 300 dot per inch scale and "bmp." file format, these images turned into electronic patient cards that were stored in a computer. The patient cards and the associated dental images are stored in an easily manageable archive in which any patient record can be found very easily. Moreover, radiographs displayed on the computer monitor were easily manipulated in size and contrast besides image magnification and rotation that facilitated visualization of bony architecture for measurements of bone loss [36,37].

For standardization of the geometric measurements radiographic template was constructed for each patient. The template helped in accurate repositioning of the X-ray film in the same position relative to the abutments. Templates were kept in water along the study period to avoid dimensional changes of acrylic resin [38,39].

The use long cone paralleling technique to detect bone changes together with Rinn- XCP periapical film holders and the individually constructed acrylic resin templates aided in obtaining a series of accurate and reproducible radiographs as well as fixing the target to film distance during the follow- up period. A special sixteen- inch long cone made of lead material was supplied by the machine was used to direct only the parallel rays to the X-ray film, thus preventing the divergence of X- rays and image magnification[40].

The Digora machine special software linear measurements system provided the mesial and distal crestal (marginal) bone height around the abutments in both groups. The Digora program calculated automatically the vertical calibration according to the value inserted in the real distance field, (fig.8 and 9).The bone height was measured mesial and distal to the abutment canine in the edentulous area every three month up to one year. The data of measurements of bone height were calculated and analyzed biostatistically [41].

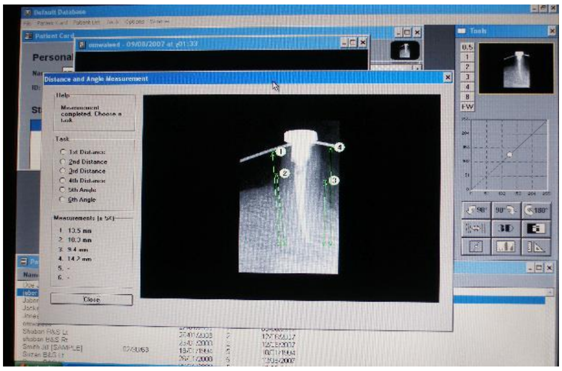

Fig. 8 The Digora linear measurements for magnet group.

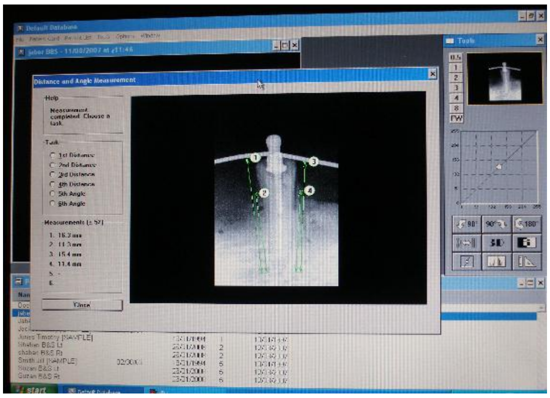

Fig. 9 The Digora linear measurements for ball and socket group.

RESULTS

Comparison between mean values for both the right and left abutments in both magnetic attachment and ball and socket attachment group in bone height revealed statistical insignificant values. Hence, the mean values for both the right and left abutments were pooled together for all the assessment measures.

Effect of Attachment Retained Overdentures on Crestal Bone Height

Comparison between the calculated mean values for the change in crestal bone height for both the magnetic and ball & socket attachment groups between each two consecutive follow-up periods were carried out using student t-test as clear in table (1) and figure (10).

The t-value for the difference in the calculated means for crestal bone loss proximal to the magnetic compared to ball & socket attachment was found to be statistically non significant at P≥ 0.05 at the intervals between insertion-3 months and 9-12 months follow-up periods. However, a significant difference between the two groups at P≤ 0.001 at the 3-6 months interval and at P≤0.01 at the 6-9 months follow-up period.

At the end of the study period the difference in crestal bone loss in between the magnetic and ball & socket attachments groups were statistical significant at P≤ 0.01.

Table (1): Mean, Standard deviation and t-value for the effect of magnetic versus ball & socket attachments on crestal bone loss proximal to the abutments:-

Time	Magnetic attachment			Ball & Socket attachment				
	Mean	±	SD	Mean	±	SD	t-value	P-value
Insertion-3m.	1.718	±	0.418	1.635	±	0.117	0.600	NS
3-6m.	1.688	±	0.109	1.473	±	0.077	5.085	***
6-9m.	1.750	±	0.355	1.510	±	0.029	2.130	**
9-12m.	1.420	±	0.397	1.543	±	0.061	-0.964	NS
Insertion-12m.	6.575	±	0.426	6.160	±	0.191	2.811	**

M = MonthNS = Non significant (P≥ 0.05)
P = Probability* Significant at (P-value ≤0.05)
t-value =Student t-test** Significant at (P-value ≤0.01)
SD = Standard deviation*** Significant at (P-value ≤0.001)

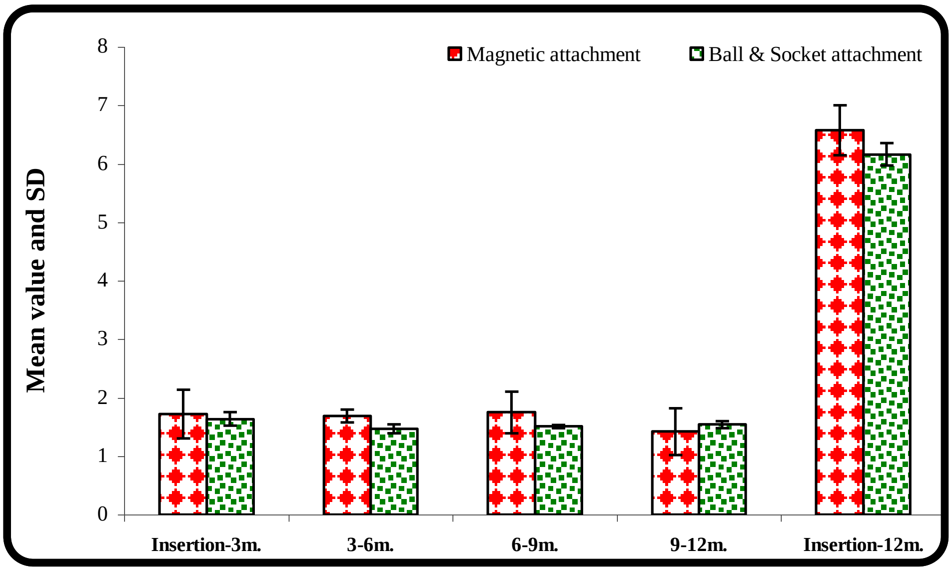

Figure (10): Effect of magnetic versus ball & socket attachment on crestal bone loss changes

DISCUSSION

Maintenance of the abutment supporting structures is considered a key factor to the success of overdenture treatment. Occasionally overdenture wearers may experience severe breakdown of the abutment supporting structures, which are of critical importance of the maintenance and success of this treatment [42].

In attempt to minimize the harmful effect of horizontal forces, magnetic and ball& socket attachments were used in this study. Abutment responses in term bone height were evaluated.

The insignificant amount of alveolar bone loss proximal to magnetic compared to ball & socket attachments during the insertion- three months period may be explained by the fact that presences of periodontal proprioceptive nerve endings provide an impulses to the neuromuscular mechanism, which is in turn provide an improved neuromuscular performance. This led to more precise functional jaw movement and prevents deviation of the mandible during closure, thus reducing the possibility of cuspal interference [43].

Furthermore, stability of the overdentures resulting from the use of magnetic and ball & socket attachments reduces the destructive horizontal and rotational occlusal forces by directing them more axially and less traumatically on the abutments. This prevents shifting of the denture base and the subsequent development of deflective occlusal contacts as both attachments were accepted clinically from the patients for the stability of the dentures during function [44, 45].

The gradual increase in the alveolar bone loss proximal to the abutments during the different follow-up periods was in agreement with the results of other studies [46, 47]. The investigators found an average bone loss of 0.9 mm in abutment supporting overdenture after one year. They related this finding to the nature of the overdenture support which allows stress to be disturbed between the abutments and the residual alveolar ridge. The reduced loss of marginal bone height could not be interpreted as a pathological change, but it could be due to bone reaction to the newly introduced prosthesis [48].

From the mechanical point of view many authors mentioned that the use ball and socket may create horizontal component of forces which is very destructive to denture stability [49,50]. Whereas the present study is in controversy with these studies.

These horizontal destructive forces were found very dangerous on the integrity of the periodontal support of abutments retaining and/or supporting the overdentures.

The results of the comparison between the two groups as related to crestal bone loss changes revealed that there was increased in crestal bone loss in the group of magnetic attachment rather than the group of ball& socket attachment. This may be due to magnetic field and its affection to the version circulation of the bone, or due to the size of alloy keeper not accordance with the size of root as the size of the alloy keeper is smaller than the size of the root of the abutment and the shape of the alloy keeper is different as it is in the form of cylinder whereas the shape of the abutment is oval, so the alloy keeper was projected out of the root of the abutment that would accumulate plaque between the alloy keeper and the root of the abutment leading to gingival inflammation and increase bone destruction. The third reason of increase bone loss in magnetic attachment was to non-equal load distribution that related to length limited of the post of the alloy keeper inside the root canal orifice, whereas the length of the post of the ball attachment direct the load along the long axis of the abutments and the load would be applied to the bone rather than to the mucosa. The results of this study were in controversy with that recorded by another researcher [50]. Finally, more study is suggested to search about the exact reason of the increased crestal bone loss with magnetic attachment.

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