Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2016;5:1:100-108.

Comparative Evaluation of Retention of Ball and Locator Attachment Based on Various Implant Angulation: In Vitro Study

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ABSTRACT

Aim: The Aim of this InVitro Study is to compare Retention of Ball Abutment and Locator Abutment Based On various Angulation of the Implants at 0,5,10 degree.

Materials and method: A metal die is prepared according to the dimension (60*30*15mm) and the counterpart also prepared to the same dimension with the vertical stops. The die is duplicated with elastomeric impression material and the auto polymerising acrylic is poured and 3 pairs of acrylic block is prepared (Block A, Block B, Block C). Two implants are placed in acrylic Block A of which one implant is placed at 0 degree and the other implant is placed at angulation of 0 degree to the distal aspect from the mid line. In Block B two implants are placed of which one implant is placed at 5 degree and the other implant is placed at 5 degree to the distal aspect from the mid line, in the same manner in Block C two implants are placed of which one is placed at10 degree and the other implant is placed at 10 degree angulation. Angulation is measured by a device called Goniometer. Three pairs of ball abutment were hand tightened in three acrylic blocks (Block A, B, C) and the retentive component is placed in the counter part of acrylic and subjected to pull test, in the same way 3 pairs of locator abutment were tightened in 3 acrylic blocks (Block A, B, C) and the retentive component is placed in the counter part of acrylic, and subjected to pull test. Pull test is done using push /pull force measuring guage. (LUTRON FG 5000 A LT, ISO 9001, Made in Taiwan).

Results: Significant difference found at locator attachment placed at 5 and 10 degree compared to ball attachment.

Conclusion: As the angulation increases within locator attachment there is no significant difference in retention when placed at 0,5,10 degrees. It shows in locator attachment retention is not altered as there is increase in angulation.

Keywords: Prosthodontics, Dentistry, Implant.

INTRODUCTION

Teeth loss may be due to trauma, caries, periodontal disease and congenital defects. Loss of teeth has a negative impact on masticatory function, esthetics and self-image. As a normal phenomenon residual alveolar bone undergoes resorption after extraction. Edentulous patients with severe

Received: Apr. 19, 2015: **Accepted**: Aug. 21, 2015
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pISSN 2278-0076
eISSN 2321-9270

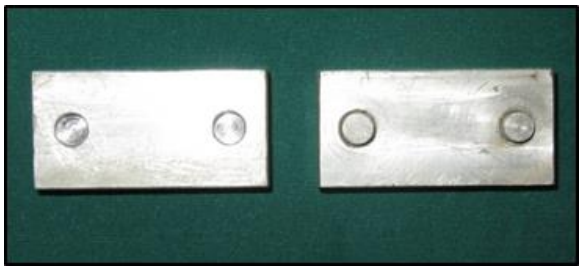

Fig 1: Metal die preparation.

Fig 2: Milling machine table to stabilize the acrylic block (0 Degree).

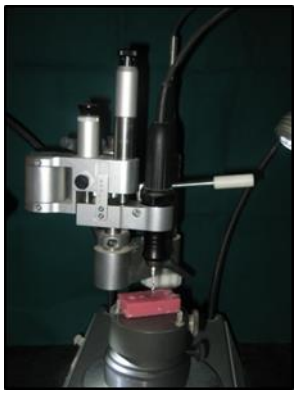

Fig 3: Drilling done with milling machine.

Fig 4: Acrylic block stabilized at (5 Degree) and angulation angulation verified using goniometer.

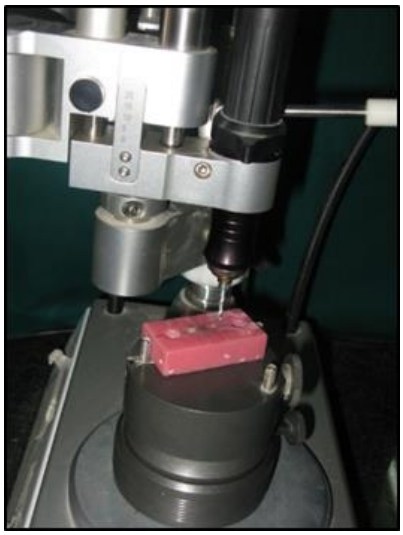

Fig 5: Drilling is made at (5Degree) in milling machine.

Fig 6: Acrylic block stabilized at 10 degree and angulation is verified goniometer.

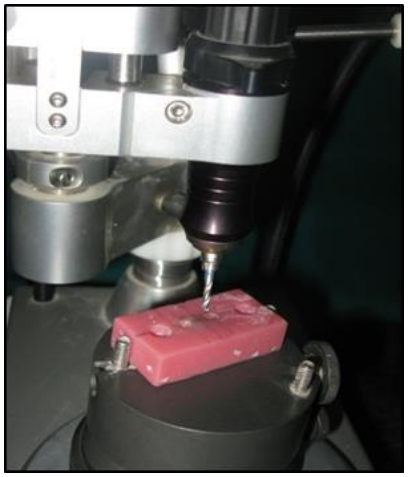

Fig 7: Drilling made at 10 Degree in milling machine.

Fig 8: 3 Pairs of Implants (3.75*11mm).

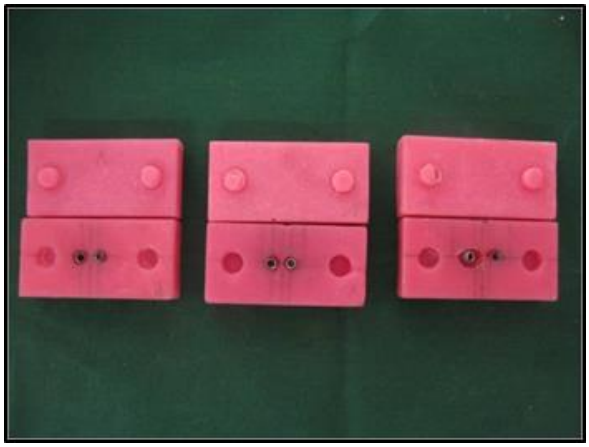

Fig 9: Implants placed and stablised using acrylic resin.

Fig 10: Pair of Ball attachment with least retentive matrix part (white ring).

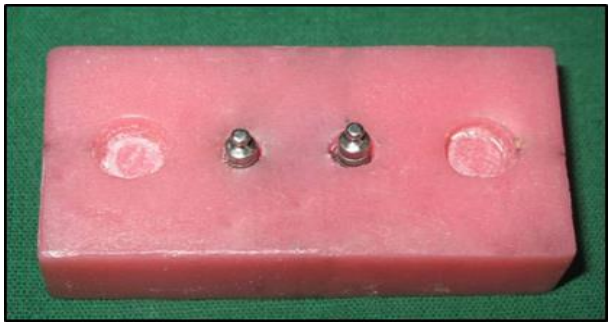

Fig 11: Ball attachment placed at 0 degree.

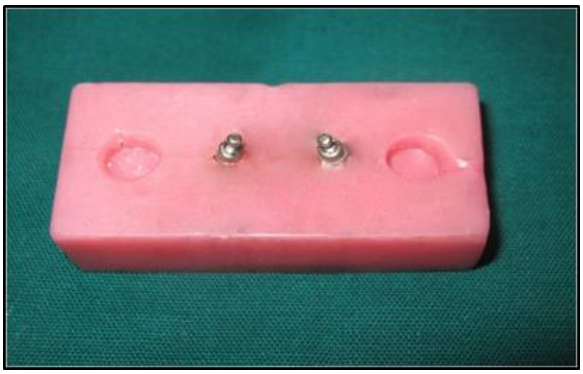

Fig 12: Ball attachment placed at 5 degree.

Fig 13: Ball attachment placed at 10 degree.

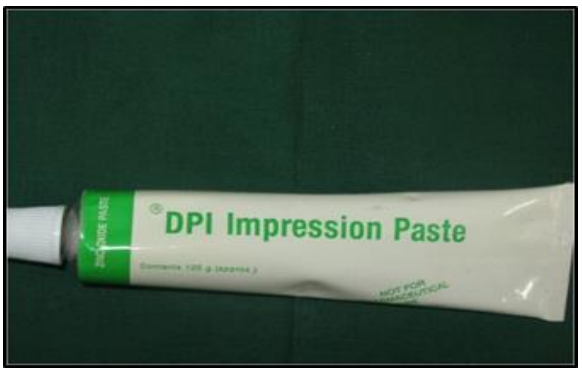

Fig 14: Zinc oxide Eugenol impression paste.

Fig 15: Markings transferred with impression paste.

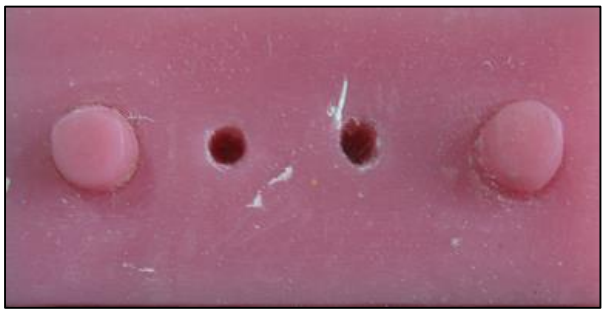

Fig 16: Relief holes created in counter block.

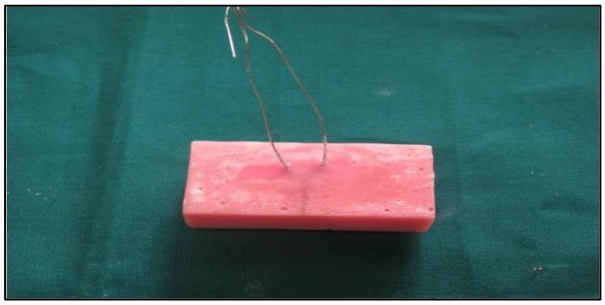

Fig 17: A 23 gauge orthodontic wire tied in the center of the block

Fig 18: LUTRON Push pull Force Measuring Gauge

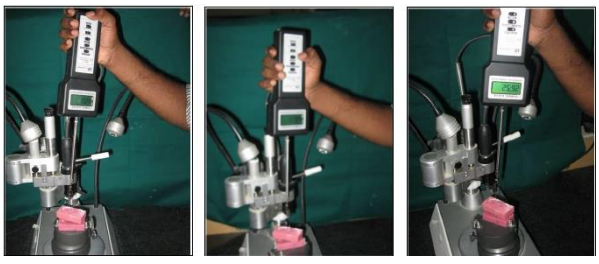

Fig 19: Retention test for ball attachment at different angulation.

resorption may experience a problem with conventional complete denture treatment because of impaired load bearing capacity. These includes pain during mastication, loss of retention and stability of complete denture.

To overcome these problems the over denture concept came in to existence in the year of 1960s as a viable treatment option. Over denture supported by tooth root is considered as a viable treatment options for edentulous patients. This tooth supported over denture retains tooth root for better retention and stability and also decreases the residual ridge resorption. Preservation of at least two roots provide a viable treatment for mandibular over denture. Over-dentures supported by natural teeth generated a decade of excitement and interest in prosthodontic circles. They were the last line of defence that successfully kept patients from becoming edentulous. Patients could chew better, their ridges did not resorb as quickly, they had dentures that were more stable and retentive[1]. In case of loss of remaining natural teeth or tooth roots it becomes completely edentulous and thus implants play a major role in those situations. By the end of 1980s P.I Branmark has provided titanium implants for tooth replacement. This over denture concept has become more popular when applied to titanium implants. The decade of tooth supported over denture was being succeeded by implant supported over denture[2].

Treatment of edentulous patients with implant-retained removable prostheses has been shown to provide a predictable and successful outcome that overcomes the functional deficiencies associated with conventional dentures. Clinically, placing implants in the edentulous mandible has become a standard treatment for patients who are not satisfied with conventional complete dentures. Two implants in the mandibular arch is used to provide predictable retention and stability for a severely resorbed mandible. This implant supported treatment option has a reported a survival rate of 94.5-100%[3]. Implants can be used in conjunction with attachments to enhance the retention and stability of overdentures. Many different attachments are currently available. Most of these attachments are compatible with the majority of implant systems[4]. Attachment systems used for implant-retained overdentures are divided into bars, balls and magnets attachment. The bar systems are used to splint the nonparallel implants,

and they provide different degrees of movement towards the tissue[5].

Implant-retained overdentures using ball-type retentive attachments have been shown to be a successful and cost-effective oral rehabilitation approach for edentulous individuals with resorbed mandibular ridges. Ideally, ball attachments should be parallel to each other to provide ease of insertion and removal and reduce wear potential. Magnetic retained denture has greater accumulations of microbial plaque around magnetic attachments because of the emergence profile of the magnet. Magnetic attachments tend to be shorter than mechanical attachments, making them useful in cases with restricted inter-occlusal space and difficult aesthetic situation.[6-9]

Compared to bar and magnet attachments, ball attachments have scored better on retention, soft tissue or mechanical complications and patient satisfaction. Problems can arise if the interarch distance or height of the denture is insufficient for ball or bar attachment use.[10,11] Among these problems are over contoured prosthesis, excessive occlusal vertical dimension, fracture of the teeth adjoining the attachments, prosthesis fracture, and a negative experience for the patient[12]. To overcome all these, Locator attachments can function well in these situations. A low profile height of the attachment components will allow enough space for adequate thickness for denture acrylic and the necessary strength of the prosthesis. In addition the attachment must be designed with the sturdy materials and wear resistant coatings for long lasting performance. Another important feature of locator attachment is that the matrix part is placed in the implant and the patrix part is placed in the denture.

In this in vitro study the aim is to compare the retentive property of ball and locator attachment based on different implant angulation such as 0,5,10 degrees.

MATERIALS AND METHOD

A stainless steel block with a dimension of 6cm length, 3 cm width and 1.5 cm height (6*3*1.5mm) is made along with its counterpart and a small inter locking mechanism (5mm height and 8 mm width) of same dimension in the laboratory (Fig-1). This metal block is duplicated using irreversible hydrocolloid Alginate (Zelganplus 9001-Iso 13485).The metal block and its counterpart is duplicated in the alginate which is mixed with water in the ratio of 15gm of powder and 40ml of water by using rubber bowl and stiff spatula for about 45 seconds to 1 min.

All the three blocks are placed in the surveying table and the table is tilted to 0,5,10 degree respectively and secured in position and the tilt is verified using goniometer (Fig10-15). These blocks are now stabilized in the Milling machine (Amman girbagh af 350, LOT AFL 944, ISO 9001; 2000) and a drills made at different angulations. Drilling is made along the long axis of the block at different angulations using 3.75*11mm diameter drill. In Block A, Block B, and Block C, two implants are placed at 0 and 0 degrees; 5 and 5 degrees; 10 and 10 degrees respectively and stabilized using acrylic resin (Fig-16, 17).In all the three groups, a pair of ball abutment (Hi tech over denture ball abutment 2mm collar with white O ring 1.5 lbs. retention) is tightened using Hex driver (Fig-18). The ball abutment has a patrix part in the implant and the corresponding matrix part in the counterpart.

In all the three blocks, a pair of ball abutment is hand tightened to respective implants,(Fig 19-21) and marking is made using Zinc oxide Eugenol paste(Fig-22,23)on the counter block and space is created to accommodate matrix part(Fig- 24). A spacer is adapted to the matrix part (-O-ring), which in turn seated over the patrix part (ball abutment), then stabilized with auto polymerizing acrylic resin. Hence in all the three groups, the matrix parts are fixed into the patrix parts correspondingly and stabilized using Milling machine.

A Hole is created in the counter block and 23 gauge orthodontic wire is tied in the midline of the acrylic block and tightened using orthodontic plier (Fig-25).Push pull machine (LUTRON 5000 CA, ISO 9001)(Fig- 26) the terminal hook is inserted into the terminal end of the orthodontic wire and subjected to pull test(Fig-27). Each block is subjected to 10 cycles of pulling test. The force at which dislodgement occurs is noted. Similarly all the three groups are tested and the reading in

which the matrix part dislodges is noted. Average of 10 cycles gives the exact measurement at which matrix part dislodges.

RESULTS

The purpose of the study is to compare the retention of locator and ball attachment based on different implant angulation such as 0,5,10 degree in an in vitro model. This study was done in an acrylic block with a dimension of 6cm length, 3 cm width and 1.5 cm height along with its counterpart of same dimension. Drilling is made with the 3.75*11mm implant drill using milling machine. Three pairs of implants placed in the acrylic block at 0 degree, 5 degree and 10 degree each and the angulation verified using Goniometer an angulation device. Ball attachments were hand tightened and the matrix part is fitted to the counterpart and stabilised using milling machine table. A 23 guage orthodontic wire is tied in the centre of the block and retention test is done using Lutron push/pull force measuring guage, Average of 10 cycles is done for statistical analysis. In the same way Locator attachment is hand tightened and the corresponding patrix part is placed in the counterpart and retention test is done using Lutron push/pull force measuring guage. Average of 10 cycle is done for statistical analysis.

Data collections were done at different angulation and statistical analysis were done (paired T test) and it shows the values within ball attachment group are significant and the values found within Locator attachment are not statistically significant. When data are compared between ball and locator attachment at 0 degree it's found to be statistically significant and mean average value is greater in ball attachment. At 5 degree the values are not statistically significant only the mean average value is greater in locator attachment. At 10 degree the values are statistically significant and the mean average is greater in locator attachment.

DISCUSSION

A Stainless steel metal die of dimension 6cm length, 3cm width and 1.5 cm height is fabricated along with its counterpart and duplicated using irreversible hydrocolloid and 3 pairs of acrylic blocks are obtained. Three pairs of acrylic blocks are grouped as block A, block B, Block C. In each block angulation are marked using goniometer and implants are placed at 0,5,10 degrees respectively. In each block pair of ball abutment was hand tightened and the relief holes created for the matrix part in the counter block and seated[13]. A 23 gauge orthodontic wire is tied in the centre of the block and milling machine table is used to stabilize the acrylic block and retention is checked in each block. In each block 10 cycles of retention test is done and the average values are noted and statistically analysed. In the same way 3 pairs of locator attachment replaced the ball attachment and hand tightened in the acrylic block and the patrix part is fixed in the counter part by creating a relief holes and stabilised using acrylic resin[14]. A 23 gauge wire is tied in to each block and milling machine table is used to stabilise the acrylic blocks and retention test is done. Ten cycles of retention test is done and the force at which the counterpart dislodges is noted, and results are statistically analysed. For both ball and locator attachment retention test is done using LUTRON push/pull force measuring guage.

The results were statistically analysed and discussed as follows.Group1 is the Retention of ball attachment in that sub group A is 0, 0 degree control group, sub group B is 5, 5 degree and sub group C is 10, 10 degree. Group 2 is the retention of locator attachment in that sub group A is 0, 0 degree control group, sub group B is 5, 5 degree and sub group C is 10, 10 degree. Paired T test is done within the group and between two groups.

Comparison done to check retention of ball attachment within control group and 5,5 degree, 10,10 degree and it shows the retention is greater in parallel implants . Vali et al[15] recommended that implants must be parallel to one another and to the path of insertion of prosthesis, especially when ball attachment are contemplated. But these guidelines may not be fulfilled and misalignment of implant may result. It is suggested that 10 degree between 2 non splinted implants can be usually tolerated, excessive wear may result from wider angles of divergence or convergence.

Comparison done to check retention of ball attachment within 5,5degree and 10, 10 and it shows retention is greater in 5,5 degree. As the

angulation increase in ball attachment the retentive value decreases. To overcome the problem of retention, the ball attachment must be parallel to each other to ensure maximum amount of retention and to prevent wear of the matrix part. According to Michael et al[16] ball attachment provide excellent retention for overdenture, but the retentive capacity of ball attachment may be altered by lack of parallelism. He investigated retention of gold and titanium matrices when placed at 0, 10, 20, 30 degree and found that significant difference in retention of gold matrice placed at 20 and 30 degree and angle is not a factor affecting retention of titanium matrices. Sergio et al[17] compared the retentive behaviour of spherical attachment when used in non-parallel and parallel implant. Two implant supported over denture with ball attachment and spherical attachment were used and the implants are placed from (0,0) degree to (15,15) degree. They found the retentive values decrease in (15,15)degree, when compared to control group. In the same way comparison done to check retention of locator attachment within parallel implants and implants placed at 5,5 degree, 10,10 degree and found there is no difference in the retention of angulated implants. Suhail et al[18] investigated the effect of cyclic dislodgement on the retention of an Overdenture Locator attachment system when 2 implants were placed at angulations of 0, 5, 10, 15, and 20 degrees. Extended range attachment used in all the groups and they found that implant angulation negatively affect attachment retention. Comparison was done to check retention between ball attachment and locator attachment and found that compared to ball angulation is not affecting retention in the locator attachment. Chien Chen et al[19]compared the freedom of rotation for selected attachment (ERA, Locator extended range, o ring attachment) and found that least retentive component offers greater degree of rotation than most retentive component. Locator extended type attachment found to be most retentive when compared to ERA and O –ring system. From this study they concluded that clinician who desires least retention and greater degree of rotation -O-ring is the attachment choice. In parallel implants ball attachment showed increase amount of retention compared to locator attachment .David et al[20] compared three different types of overdentures in relation to prosthesis retention, stability, tissue response, patient satisfaction and preference, complication and treatment outcomes. Comparison done between 2 implant retained ball attachments, 2 implant retained bar attachment, 4 implant retained bar attachment. In this study 2 implant retained ball attachment showed effective results compared to bar attachments. Glen et al[21] investigated the predictability of simplifying mandibular over denture using single stage surgery and immediately loaded single implant with ball attachment and found that it is safe, reliable, cost effective to retain a mucosa borne over denture. When a clinician selects an attachment system for implant overdentures, the most important aspect is to understand the advantages and disadvantages of the attachments to improve the success rate of implant overdentures and the quality of life of the patients.

CONCLUSION

Within the Limitation of the study the following conclusion can be made When compared to locator attachment, ball attachment showed increase amount of retention when the implants are placed at 0 degree. When the implants are placed at 5 degree there is no significant difference between ball and locator attachment. When the implants are placed at10 degree there is a significant difference between ball and locator attachment. Locator attachment showed increase amount of retention. As the angulation increase within ball attachment, implants placed at 0 degree shows more retention compared to 5 and 10 degree. As the angulation increases within locator attachment there is no significant difference in retention when placed at 0,5,10 degrees. It shows in locator attachment retention is not altered as there is increase in angulation.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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