Original Article

Comparison of Retentive Force in Four Attachment Systems in Implant-Supported Overdenture of the Lower Arch

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KEY WORDS
Attachment;
Overdenture;
Retention

ABSTRACT

Statement of Problem: Along with the rapid population growth in recent decades, there has been an increase in the number of edentulous patients who have complications with conventional denture. This entails the use of dentures, such as implant overdenture, which are more efficacious.

Purpose: The purpose of this study is to compare four types of different attachment systems; two prefabricated and two castable attachments.

Materials and Method: A model of lower edentulous arch was constructed out of dental stone. Two parallel implants were placed in the canine region. A single cast metal chrome cobalt framework was fabricated to provide reinforcement for experimental overdentures and it splinted the two attachments on the cast. To conduct this study, four groups with six numbers of attachments in each group (superflex ball, locator, castable ball on bar, castable bar) were selected. All the samples were put in a Universal Testing Machine and a tension force with the speed of 50 mm/ min was exerted to separate the framework from the cast. The tension force was recorded and the first two prefabricated attachments (superflex ball and locator) were compared with the second two castable attachments (ball on bar, castable bar).

Results: The findings of this study revealed that retention force of castable ball on bar was greater than the other three attachments (35.31±3.14N). With regard to the strength of retentive force, superflex ball took the second place (33.33± 3.11 N) and locator (20.90± 3.74N) and castable bar (14.74± 1.15N) took the third and the forth places, respectively (p <0.001).

Conclusion: The retentive force of castable ball on bar was similar to that of superflex ball. Therefore, the use of this cheap attachment; castable ball on bar, is preferred to its prefabricated counterparts. The retentive force of this kind of attachment is greater than expensive locators. The retentive force of castable bar was similar to that of locator, although the former was a bit weaker than the latter. Therefore, when less retention is needed, castable bar can be a suitable choice, and when more retention is needed, castable ball on bar is preferable.

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Introduction

The constant improvement in the standard of hygiene has led to high life expectancy among people. The average age of the elderly has also increased [1-3]. As people become older, the need for oral hygiene is much more felt. Unfortunately, however, edentulism has increased in Iran not only in the elderly but also in the youth and it can be due to systemic diseases; inadequate health care, especially in smokers; drug abuse; no periodic visit of a dentist; and no dental

insurance. There is a need to replace lost teeth in order to repair the defects, such as chewing disturbance; indigestion; speech disturbance; and esthetic [4]. There are many ways to this end. Perhaps, the first choice can be the conventional complete denture for both the upper and the lower jaws, but this leads to many problems, such as ridge resorption; nausea; stability; and retention deficiency and makes both patients and dentists go to fixed treatment options, such as implant fixed prosthesis. But due to the high level of costs and extensive surgery, especially in old patients with many systemic diseases, this type of treatment is not recommended [5-9]. Overdentures solve many of, the above mentioned, problems with fixed prosthesis. Implant overdentures connect to implant fixtures with a component state such as attachment [10]. This component consists of two parts: male and female [11].

Attachments can be divided into many types, only on the basis of their differences in flexibility, casting precision, production process, geometrical shape and cross section. Shafie, with regard to cross section, divided attachments into the following types: 1. Clips and bars, 2. Studs, 3. Magnets, 4. telescopic coping [12]. Furthermore, precision and semi-precision are two types of attachments with regard to production process and joint and unit are two other types with regard to flexibility [13].

The purpose of this study was to compare the retentive force in four attachment systems in implant-supported over denture of the lower arch.

If retentive forces of both castable and prefabricated attachment are similar, the former can be used because it is more available and cheaper than the latter. The most usable prefabricated attachments in Iran are locator and superflex ball, and castable attachments which include castable bar and castable ball on bar [14].

Chung compared the retention force of different colors of superflex ball and locators. The results of the study indicated that retention force of superflex ball and Locators were almost equal [15].

Botega (Peracicaba university, Brazil) compared retention and fatigue resistance of four kinds of overd enture attachments (two kinds of superflex ball and two kinds of prefabricated bar clip). Finally, it was stated that retention forces of bar clip and superflex ball were equal [16]. Sadig study mentioned that Locator retention was more than ball [17]. Fu et al., compared retention force of three prefabricated and two machine milling attachments. Their findings indicated that retention forces of all groups were nearly equal after the first tension cycle [18].

Materials and Method

In this study a model of lower edentulous arch was constructed in dental stone (Louisville, KY Dental St-one, Whip Mix Corp., Resin Rock). All edentulous ridge undercuts were eliminated. Two parallel implants (ITI System, Straumannco, Switzerland) with 4.1 × 12 mm were placed in the canine region with a distance of 22mm between them. A single cast metal chrome cobalt framework (Wironium, BEGO Herbst Co, Bre-men, Germany) was fabricated to provide reinforce-ent for experimental overdentures. The cast metal framew-ork also possessed four withdrawal loops that were engaged during direct pull-off testing (Fig. 1).Then two superflex ball attachments (Rein Co., Italy) were inserted in the implants (Figure 1a).

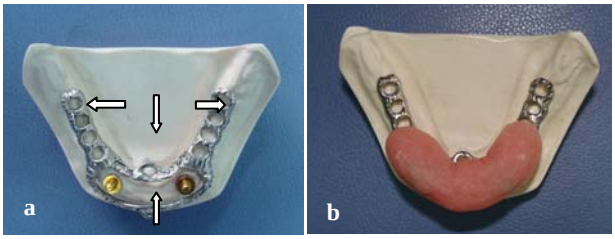

Figure 1a The cast metal framework possessed four withd-ra-wal loops that were engaged during direct pull-off testing (white arrows).Then two superflex ball attachments were inserted in the implants. **Figure 1b** Self-cure acrylic resin was placed over the housi-ngs and it splinted the two attachments on the cast.

After that, first the pink rubber cap and then the metal housing were inserted into attachments with a 0.4 mm distance between them. Self-cure acrylic resin (Densply International Inc., Co.) was placed over the housings and splinted the two attachments on the cast (Figure 1b).All of these were also done for the two locators (Straumann Co., Switzerland), i.e. with the pink rubber cap and the metal housing and with a 0.4 mm distance between cap and housing on the cast. The castable plastic hader bar (Rein Co., Italy) was waxed up between the two implants in contact with ant ridge. Then plastic hader bar was casted (Figure 2a) and two yellow plastic clips were inserted into the bar (Figure

2b). After that, self-cure acrylic resin was put over the assembly.

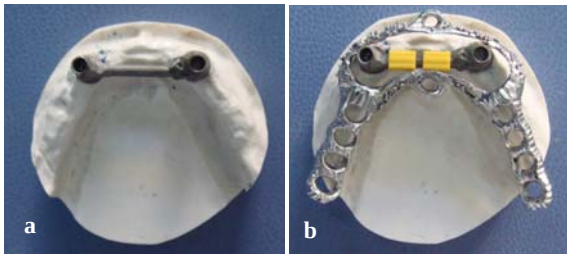

Figure 2a Plastic hader bar was casted **2b** Two Plastic clips were inserted into bar.

The castable plastic ball on bar (Rein Co., Italy) with two balls on bar and the pink rubber caps and the metal housings and with a 0.4 mm distance between the caps and the housings, was waxed up between the two implants in contact with ant ridge and casted into metal form, putting plastic caps and housings and self-cure acrylic resin, too (Figure 3).

Figure 3 The castable plastic ball on bar was waxed up between the two implants which were in contact with ant ridge.

Machine screws were incorporated into the cast metal framework so that overdenture housing, containing different attachments, could easily be secured and removed during testing. Of course, before inserting this assembly in the machine, the cast was trimmed because it was too big to be inserted in the machine. Overall, 24 overdentures were fabricated and six specimens of each of attachment system were tested. Retentive force for each of experimental overdentures was exerted at a cross-head speed of 50 mm/min. This cross-head speed has been reported to approximate the clinically relevant movement of the denture away from the edentulous ridge. A metallic chain connected the Universal Testing Machine (Technological Model 5T, China Material Co., Taipei, Taiwan) to the overdenture framework at the withdrawal loops. Vertical testing forces simulated anticipated overdenture removal forces. Peak load-to-dislodgement and strain-at-dislodgement were recorded and calculated from stress-strain curves in order to determine the retention force and the change of distance between the patrix and the matrix of each attachment system.

Data analysis

One-way analysis of variance (ANOVA) was run to analyze the data (SPSS16), while Tukey post-hoc tests were used for pair wise comparisons (α=0.05).

$$N = \frac{(1-\frac{a}{2}+Z1-B)2(\mu1-\mu2)2}{(\mu1-\mu2)^2} \qquad N = \frac{(1.96+84)2(3.4+2)2}{(4.5)^2} = 6.02$$

Results

Based on the findings of this study, retention force of castable ball on bar was greater than other attachments (35.31±3.14N). Superflex ball took the second place in this regard (33.33±3.11 N). Locator (20.90±3.74N) and castable bar (14.74± 1.15N) were at third and forth places, respectively (p <0.001) (Figure 4 and Table 1).

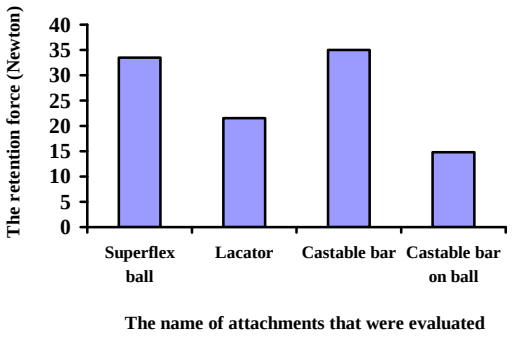

Figure 4 Comparison of Retentive Force in Four Attachment Systems in Implant -Supported Overdenture

Table 1 Comparison of Retentive Force in Four Attachment Systems in Implant -Supported Overdenture (maximum minimum range and standard deviation)

Name of attachments	Max	Min	SD	
Castable ball on bar	38.61	32.01	3.14	p = 0.057 p < 0.001 Lacator p < 0.001 Castable bar
Superflexball Lactor	36.6	30.06	3.11	p < 0.001 Castable bar
Locator	24.83	17.05	3.74	p = 0.007 Castable bar
Castable bar	16.02	13.53	1.15	

Discussion

Castable ball on bar had almost similar retention to superflex ball. So, this cheap attachment can be used instead of the prefabricated ones in indicated patients. Retention of this attachment was more than expensive

locator, too. Castable bar attachment was less retentive than locator but the difference was not so much. In the present study, before inserting this assembly in the machine, the cast was trimmed, because it was too big to be inserted in the machine. In summary, it can be said that when less retention is needed, castable bar can be a suitable option and when more retention is needed castable ball on bar. The results of this study are in agreement with some other studies, a few of which will be mentioned below.

Chung compared the retention forces of different colors of superflex ball and locators. An edentulous mandibular model was constructed through incorporating two parallel 4.0 mm x 13 mm, Branemark, implants which were placed in the canine regions. Attachments were embedded in a metal-reinforced experimental overdenture, designed to be dislodged from the model by a Universal Testing Machine. Tensile dislodging force was exerted on the overdenture at a cross-head speed of 50 mm/min. Then, five overdentures were constructed for each of the attachment systems. The evaluated attachments were Hader bar & metal clip, Locator LR pink, Locator LR white, Spheroflex-ball, Shiner magnet, Maxi magnet, Magnedisc magnet, ERA white, and ERA gray. Each apparatus was tested with 5 specimens per attachment system. Peak load-to-dislodgement was measured.

Finally, it was stated that retention force of superflex ball and Locator was almost the same. This is in line with the results of the present study [15].

Botega (Peracicaba university, Brazil) compared retention and fatigue resistance of four kinds of overdenture attachments (two types of superflex ball and two types of prefabricated bar clip). 40 samples were divided into 4 groups, each of 10. All the samples were put in artificial saliva and 5500 tension cycles with 0.8 Hz frequency. Then the Universal Testing Machine was used to evaluate samples retention. Finally, it was claimed that retention force of prefabricated bar clip and superflex ball were equal. This is not similar to our study. This difference may arise from the type of bar which was prefabricated in Botega study [16].

Sadig did a study in which two model designs were selected based on the number and location of the inserted implants: In the first setup, two implants were placed in the canine regions; in the second setup, two implants were placed in the canine regions and two in the premolar regions. For each model, three types of connectors were used: magnets, balls, and locators. Then, 10 resin bases were fabricated and three hooks were fixed at tripodal locations for chain testing. The finding of the study revealed that Locator retention was more than ball. This is in disagreement with the findings of the present study, perhaps due to the difference in retention force of different colors of caps, either locators or superflex balls, and due to the fact that in both of them different colors of caps have different retention forces [17].

Fu et al., compared retention force of three prefabricated and two machine milling attachments. Three types of ERA matrices, one prefabricated and two castable were used. There were 10 samples in each group and white nylon patrices were transferred to denture bases. All samples were tested at the speed of 0.2 mm/min using an Instron machine. ANOVA and Student t-test were used to analyze the data. Retention forces of all groups, after the first tension cycle, were almost equal. Apparently, it is in disagreement with the findings of the present study, although the difference between the two studies, and in this regard, is subtle and not significant [18].

Alsabeeha et al. compared retention forces of six different attachments (four types of ball attachment and two types of locator attachment) in the lower arch. Two prototype ball attachments of larger dimensions (7.9 and 5.9 mm) and four balls and stud attachments with standard dimensions (2.25 and 4.0 mm) were evaluated on three identical test casts. A Universal Testing Machine was used to exert a vertical dislodging force at a cross-head speed of 50 mm/min to each overdenture sample from the anterior direction. A total of 300 pull tests were conducted (50 per attachment system). The maximum retentive force to separate each overdenture from the supporting implant was measured. They indicated that locators had more retention force and ball attachments demonstrated less retention than locators. This is in agreement with the results of our study [19].

References

[1] Truhlar RS, Casino AJ, Cancro JJ. Treatment planning

of the elderly implant patient. Dent Clin North Am 1997; 41: 847-861.

[2] Thompson GW, Kreisel PS. The impact of the demographics of aging and the edentulous condition on dental care services. J Prosthet Dent 1998; 79: 56-59.

[3] Budtz-Jorgensen E. Epidemiology: Dental and prosthetic status of older adults. In: Budtz-Jorgensen E(ed): Prosthodontics for the elderly: diagnosis and treatment. 1st ed., Chicago, IL: Quintessence; 2005. p. 1-21.

[4] MacEntee MI. The impact of edentulism on function and quality of life. In Fein JS, Carlsson GE. Implant overdentures: The Standard of Care for Edentolus Patients. 2nd ed., Chicago: Quintessence; 2008. p. 23-28.

[5] van Kampen FM, van der Bilt A, Cune MS, Bosman F. The influence of various attachment types in mandibular implant-retained overdentures on maximum bite force and EMG. J Dent Res 2002; 81: 170-173.

[6] van Kampen FM, van der Bilt A, Cune MS, Fontijn-Tekamp FA, Bosman F. Masticatory function with implant-supported overdentures. J Dent Res 2004; 83: 708-711.

[7] Davis DM, Packer ME. Mandibular overdentures stabilized by Astra Tech implants with either ball attachments or magnets: 5-year results. Int J Prosthodont 1999; 12: 222-229.

[8] Thomason JM, Lund JP, Chehade A, Feine JS. Patient satisfaction with mandibular implant overdentures and conventional dentures 6 months after delivery. Int J Prosthodont 2003; 16: 467-473.

[9] Burns DR, Unger JW, Elswick RK Jr, Beck DA. Prospective clinical evaluation of mandibular implant overdentures: Part I--Retention, stability, and tissue response. J Prosthet Dent 1995; 73: 354-363.

[10] Locker D. Patient-based assessment of the outcomes of implant therapy: a review of the literature. Int J Prosthodont 1998; 11: 453-461.

[11] Mahdizadegan E. Abuse and neglected of elders. 1st ed., Pardaj: Isfahan; 2009. p.7-8

[12] Shafie H. Clinical and Laboratory Manual of Implant Overdentures. 1th ed., St Louis: The CV Blackwell Co.; 2007. p. 32-33.

[13] Attard N, Wei X, Laporte A, Zarb GA, Ungar WJ. A cost minimization analysis of implant treatment in mandibular edentulous patients. Int J Prosthodont 2003; 16: 271-276.

[14] Epstein DD, Epstein PL, Cohen BI, Pagnillo MK. Comparison of the retentive properties of six prefabricated post overdenture attachment systems. J Prosthet Dent 1999; 82: 579-584.

[15] Chung KH, Chung CY, Cagna DR, Cronin RJ Jr. Retention characteristics of attachment systems for implant overdentures. J Prosthodont 2004; 13: 221-226.

[16] Botega DM, Mesquita MF, Henriques GE, Vaz LG. Retention force and fatigue strength of overdenture attachment systems. J Oral Rehabil 2004; 31: 884-889.

[17] Sadig W. A comparative in vitro study on the retention and stability of implant- supported overdentures. Quintessence Int 2009; 40: 313-319.

[18] Fu CC, Hsu YT. A comparison of retention characteristics in prefabricated and custom-cast dental attachments. J Prosthodont 2009; 18: 388-392.

[19] Alsabeeha N, Atieh M, Swain MV, Payne AG. Attachment systems for mandibular single-implant overdentures: an in vitro retention force investigation on different designs. Int J Prosthodont 2010; 23: 160-166.