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

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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.

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 recom-

mended [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 compo-
nent 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: 
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 overdenture of the lower arch.

If retentive forces of both castable and prefabric-
ated 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 (Peracica 
university, Brazil) compared retention and fatigue resistance of four kinds of over-
ture 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 
early 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 
(“I” System, Straumannco, Switzerland) with 4.1 x 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-
ment 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).
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 patrrix 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 ($\alpha=0.05$).

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).

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

<table>
<thead>
<tr>
<th>Name of attachments</th>
<th>Max</th>
<th>Min</th>
<th>SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castable bar on bar</td>
<td>38.61</td>
<td>32.01</td>
<td>3.14</td>
<td>$p=0.057$</td>
</tr>
<tr>
<td>Superflexball</td>
<td>36.6</td>
<td>30.06</td>
<td>3.11</td>
<td>$p&lt;0.001$ Castable bar</td>
</tr>
<tr>
<td>Superflexball</td>
<td>24.83</td>
<td>17.05</td>
<td>3.74</td>
<td>$p=0.007$ Castable bar</td>
</tr>
<tr>
<td>Locator</td>
<td>16.02</td>
<td>13.53</td>
<td>1.15</td>
<td></td>
</tr>
</tbody>
</table>

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, Spheroflexball, 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 (Peracicaiba 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 triporodal 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


