Original Article

Comparison of Three Attachments in Implant-Tissue Supported Overdentures: An *In Vitro* Study

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Abstract:

Objective: Retention and resistance of the implant-tissue supported overdenture may be affected by the type of attachment. The aim of this research was to compare the retention and resistance of Nobel Biocare Ball (NBB), Nobel Biocare Bar and Clip (NBBC) and Sterngold ERA Red (ERAR) attachments on an implant-tissue supported overdenture model.

Materials and Methods: The attachment samples were divided into 3 groups of NBB, NBBC, and ERAR (5 samples in each group). Two parallel Nobel Biocare Branemark implants were placed symmetrically at the symphysis region of a mandibular test model. A metallic overdenture was fabricated precisely adapted to the model and attached to a Zwick testing machine (crosshead speed of 51 mm/min). Dislodging tensile forces were applied in three vertical, oblique, anterior-posterior directions and two situations, at the beginning and after 100 times of insertion/removal of the overdenture, for each sample. The maximum dislodging force was measured. A One-way ANOVA test was employed followed by Tukey's test.

Results: ERAR was the most retentive and resistant in both situations. NBB and NBBC showed the same anterior-posterior resistance at the beginning. All test groups represented a large amount of retention and resistance loss after the insertion/removal of the overdenture, while NBBC showed a higher loss of anterior-posterior resistance than NB.

Conclusion: A highest level of retention and resistance was seen in ERAR. The retention and resistance were affected by the wear of attachments.

Key Words: Denture, Overlay; Denture Precision Attachment; Dental Prosthesis Retention

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INTRODUCTION

Patients who are edentulous in the lower jaw and have to wear lower denture would usually complain of the poor retention. The retention is directly related to the vertical and torsion forces received, in other words, denture resistance against separation force from its sit. Denture stability is believed widely to be related to resistance against other forces like oblique and anterior-posterior forces [1]. The patient's satisfaction is directly influenced by the amount of denture retention as it has been shown through several studies [2-4]. The need for correcting the patient's problems with faul-

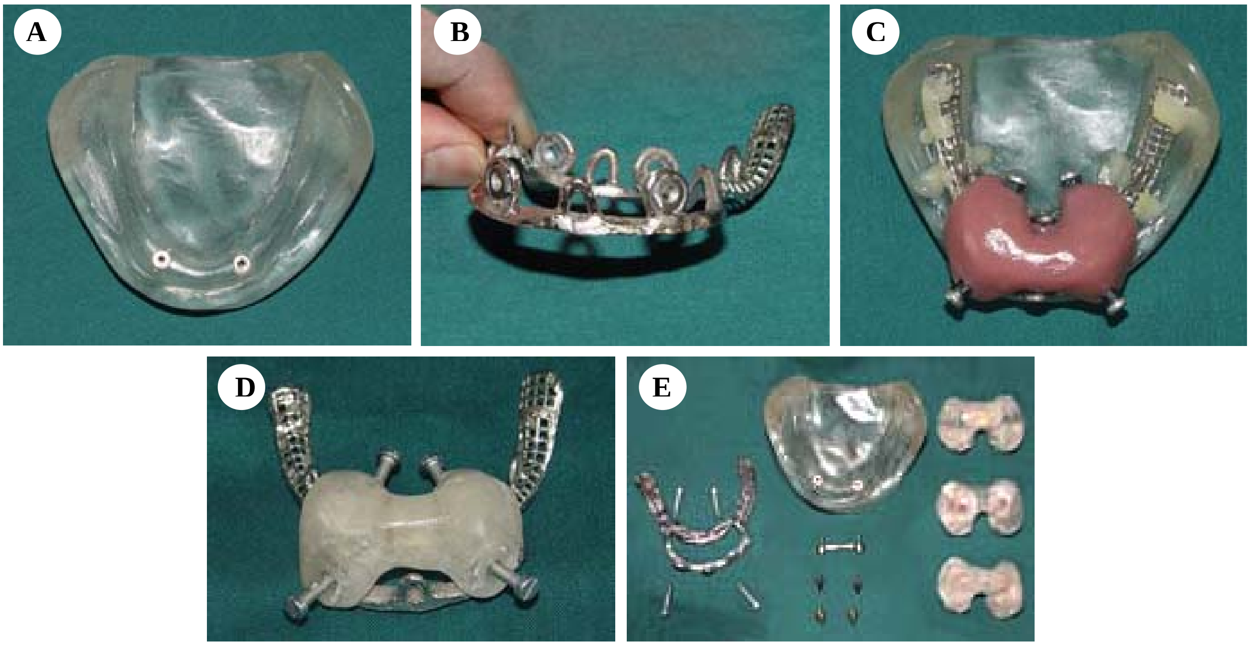

Fig 1. Model with 2 implants (A) Overdenture (B) Prototype (C) Overdenture housing (D) Components(E).

ty denture is an inevitable consequence of retention failure and residual ridge resorption [5]. Several different strategies have been introduced to overcome the problem, one of which is the use of dental implants [6]. Three distinct methods of prosthetic treatments based on implants in the lower jaw are:

1. Implant supported fixed prosthesis (FP-1, FP-2, FP-3)
2. Removable implant supported overdentures (RP-4)
3. Combined implant-tissue supported overdentures (RP-5).

The third of the above mentioned methods has the advantage of reducing the number of implants with a more simplified prosthetic approach. The overall cost reduction is also achieved through the use of prefabricated attachments [7]. Intra-osseous implants are considered as acceptable abutments in conjunction to attachments for efficient retention of the overdentures [8]. Factors involved in choosing the type of attachment include available space, maintenance necessity, spare part availability and ease of change, force distribution to the soft tissue or implant and the level of retention [6]. Another important fact is the level of wear seen in attachments following the use of overdenture [9]. The aim of this research was to compare the effects of three different attachments; Nobel Biocare Ball (NBB), Nobel Biocare Bar and Clip (NBBC) and Sterngold ERA Red (ERAR) on the retention and resistance of implant-supported overdentures.

MATERIALS AND METHODS

This *in vitro* investigation was performed on a total of 15 samples divided into three groups of five. Each group was designed to include the attachments with ERAR (0 degree ERA Micro NP Abutment only, 1 mm cuff and Micro ERA Male-Red Overdenture 5, Sterngold, USA), the attachments with NBBC (Gold Adapt & Gold Abutment Bar and Clip attachment, Nobel Biocare, Sweden) and attachments with NBB (Ball Abutment Titanium, Branemark System, RP 1 mm and Plastic Cap, Nobel Biocare, Sweden). All samples were tested for the retention and resistance of overdenture on vertical, oblique and anterior-

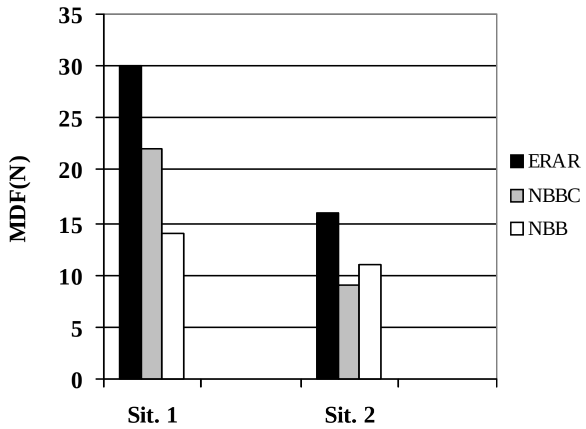

Fig 2. Comparison of retention of the attachments based on vertical tensile force.

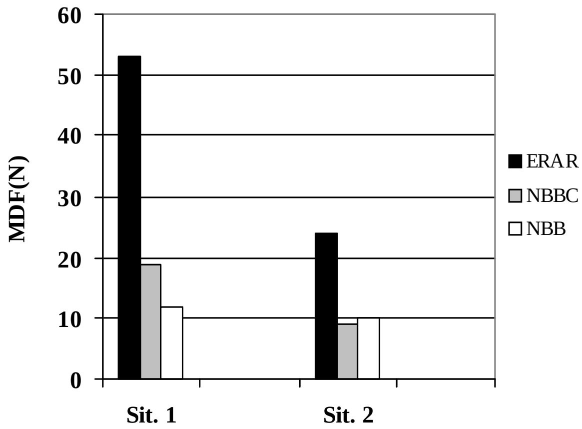

Fig 3. Comparison of oblique resistance of the attachments based on oblique tensile force.

posterior tensile force load. Recordings were made after the first insertion of the overdenture (Sit. 1) and also following 100 times of insertion/removal process (Sit. 2).

An acrylic lower jaw model was used with no undercuts. A pair of implants, 3.75×10 mm, (MK III, Branemark System, Nobel Biocare, Sweden) was inserted at both sides of the midline at the symphysis region in a parallel position. A milling machine (Paraskop M, Bremen, Germany) was employed to avoid any fault in the angulation of insertion (Fig 1-A).

A framework of cobalt chromium alloy (Wiironit, Bego, Bremen, Germany) was fabricated to fit on the two implants and the model. Therefore a metallic overdenure was made. Metallic structure was used for its durability and stability in all stages of the experiment [10]. Four stainless steel bands were soldered to the framework, which was positioned at the anterior part of the overdenture close to the implants. Bands were designed to attach the overdenture housing to the overdenture. Four hooks were designed as parts of the overdenture. Two of them were placed at the first molar's area on each side. The others were established on the midline in the buccal and lingual side of the ridge. The overdenture was attached to the testing machine through the hooks (Fig 1-B). A prototype of overdenture housing was then constructed over the metallic overdenture by use of a light cure acrylic resin (VLMC, Vita, Badsackingen, Germany) (Fig 1-C). All overdenture housings were duplicated from the prototype and fabricated by use of a self cure acrylic resin (Orthocryl, Dentaurum, Ispringen, Germany) (Fig 1-D). Therefore, an acrylic overdenture housing was made for each sample (totally 15). One part of the attachment was attached into the overdenture housing and the other part, the abutment, was screwed on the implant (Fig 1-E).

After the confirmation of appropriate sitting of the overdenture and adaptation of attachments, a series of measurements were started for each sample. A Zwick testing machine was used to load and measure the tensile forces. It included hardware and software. Recordings were made at 51 mm/min speed similar to that of denture move at bite and mastication [11]. Vertical force was measured to assess the retention while oblique and anterior-posterior forces were evaluated for resistance testing. Maximum dislodging force (MDF) [9] was recorded at the point of complete detachment of the overdenture from the model. Data were finally subjected to an analysis using one-way ANOVA test as well as Tukey's test.

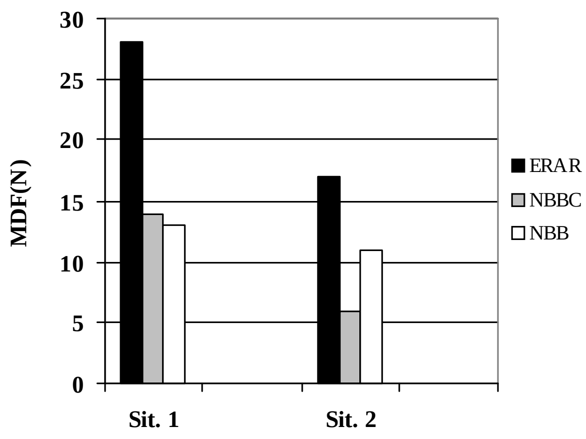

Fig 4. Comparison of anterior-posterior resistance of the attachments based on anterior-posterior tensile force.

RESULTS

Based on the results derived from the collected data, the clinical behavior of three different attachments tested were not similar during application of different forces. As the data was normally distributed, one-way ANOVA test was performed to compare the differences among three attachments for their force tolerance.

At the beginning (Sit. 1), Tukey's test revealed that there was significant differences between ERAR/NBB, ERAR/NBBC and NBBC/NBB for vertical and oblique tensile strengths (P<0.001). This result was reemphasized by one-way ANOVA test (P<0.001). Therefore, ERAR had the highest retention and oblique resistance and NBB had the least. For anterior–posterior tensile strength, Tukey's test showed significant differences between ERAR/NBBC and ERAR/NBB (P<0.001), while there was no significant difference between NBBC and NBB (P=0.528). So ERAR had the highest anterior-posterior resistance but NBBC and NBB had the same. Figs 2-4 show MDF measured for these attachments under vertical, oblique and anterior-posterior tensile forces in both situations (Sit. 1 and 2).

In Sit. 2, these data were statistically significant in their differences among different attachments for vertical and oblique tensile strengths, using one-way ANOVA test (P<0.001). However, Tukey’s test on NBBC/NBB showed no statistically significant difference for vertical (P=0.198) and oblique tensile strengths (P=0.462). ERAR had the highest retention and oblique resistance, while NBBC and NBB had the same. A further Kruskal-Wallis test performed on three groups in anterior-posterior tensile strength showed significant differences (P<0.01). ERAR had the highest anterior-posterior resistance and NBBC had the least.

The paired t-test performed to evaluate the condition of the three attachments in two different situations (Sit. 1 and Sit. 2) represented statistically significant differences (P<0.01). This indicated that the insertion/removal of overdenture for 100 times caused the differences between Sit. 1 and Sit. 2 in all three groups (ERAR, NBBC and NBB).

DISCUSSION

Over the past three decades the use of implant-tissue supported overdenture has raised considerably among dentists. It is mainly related to the rise in patient awareness and availability of attachments to the dentist. Several force directions are considered as applied in the mouth during function of the overdenture with retention being the most critical issue. Two important points of view are considered on the retention of prosthesis, including the patient’s feeling and the dentist’s assessment. The latter which is measured during maximum load force application was surveyed in this research.

Results of the current research revealed that in Sit. 1, ERAR has the highest resistance against vertical, oblique and anterior-posterior tensile forces. This means that overdenture has a higher retention and resistance potential with a significant difference from the other two attachments. This difference could be due to the design of ERAR as being intra-radicular. This is explained further by a female segment on the abutment of the attachment in addition to high and parallel abutment walls (5 mm length). The NBB showed the least MDF against vertical, oblique and anterior-posterior tensile forces. This is concluded to be due to the extra-radicular design in addition to free movement of the male component inside the female component. Retention and resistance of NBB was in the least level while ERAR was at the most with significant differences (P<0.001).

Anterior-posterior resistance of ERAR was also at the highest level as mentioned before, while no differences were established between NBBC and NBB (P=0.528). Petropoulos [12] has reported a roughly similar result on NBB and NBBC characteristics while results reported on ERAR were different from the result achieved in this research. This could be due to the use of Sterngold ERA of intra-radicular type which was not the case in the earlier mentioned study.

Results following several insertions and removals (Sit. 2) showed a considerable reduction in retention and resistance of overdenture on attachments possibly due to constant wear (P<0.01). This difference was statistically significant even in several insertion/ removal tests which the level of MDF against vertical, oblique and anterior-posterior forces was higher in ERAR than the others (P<0.001).

In Sit. 2, there were no differences in retention and oblique resistance of NBB and NBBC (P=0.198, P=0.462), but the anterior-posterior resistance of NBB was more than NBBC (P<0.01). It could also be explained by the material the attachments were made of, resulting in a higher resistance to wear in NBB compared to NBBC.

CONCLUSION

Based on the results of this research, clinical behaviors of these attachments (ERAR, NBBC, NBB) have been well identified. Therefore, the dentist can choose an appropriate attachment in implant-tissue supported overdentures according to the clinical situation.

It is recommended to use ERAR attachment when a high amount of retention and resistance is necessary. For example, for a patient who has severe residual ridge resorption or used to remove and insert the denture frequently, ERAR attachment should be applied.

NBB and NBBC attachments would be the choice when there is low demand of retention and resistance for overdenture. These are suggested for the patients with dexterity problems or poor hand manipulation.

Insertion and removal of overdenture gradually causes loss of retention and resistance due to the attachment's wear. However NBBC is affected by wear more than NBB.

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