Evaluation of Different Types of Cement in Full Arch Implant Fixed Partial Prosthesis

SUMMARY

Background: For cement-retained implant prostheses, the retention forces of luting cements are an important criterion when selecting luting cement.

Purpose: To evaluate different types of cement in full arch implant fixed prosthesis to fit on solid titanium abutment.

Material and Methods: An artificial mandible composed of self-polymerizing acrylic resin was made. 8 ITI implant analogs were mounted in the self-polymerizing acrylic resin using a surveyor and placed in centrals, canine, second premolar and molar teeth region for each side. Prefabricated burnout caps were placed on the titanium abutments and wax loops added to the occlusal surface; samples were casted with base metal alloys. 4 permanent and 3 provisional cements were tested in this study. After cementation, samples were subjected to a pullout test using an Instron universal testing machine at a crosshead speed of 0.5 mm/min. Loads required to remove the crowns were recorded and mean values for each group determined. The data were submitted to ANOVA, post hoc least square differences (LSD) and paired specimens test at confidence interval of 95%.

Results: The mean values of loads in Newton at failure for the various cements were as follows: Cavex 83.55 N, Relyx Temp NE 153.4 N, Premier Implant 335.5 N, Adhesor 256.1 N, Adhesor carbofin 401.3 N, Kavitancem 424.6 N. There were statistical significant differences between tensile bond strength values of all the cements (P<0.05).

Conclusions: In the study, the higher bond strength value was found with Kavitancem, the weakest value with Cavex; amongst the provisional cements, the highest bond strength value was found with Premier cement.

Clinical Implications: Retention values of casting to natural teeth versus metallic implants may be very different for the same cement and cannot always be compared. It is clearly recognized that the retentive force mainly depends on the properties of the cement used.

Keywords: Implant Supported Prosthesis; Tensile Bond Strength; Cements

Introduction

In recent years, there has been a remarkable progress in the field of implant dentistry. However, many questions have arisen regarding the materials and techniques used in clinical practice. One of the questions is related to the method by which fixed partial dentures (FPD) are connected to underlying implants: screw retained or cemented? The use of screw retained versus cement-retained implant restorations has been subject of controversy in the literature. Cemented-implant-supported restorations (CISR) are routinely used in dentistry. This approach resembles conventional prosthetic procedures. As distinct advantages for the cemented technique, CISR list better aesthetics, passivity of the framework, better occlusion, simplicity of fabrication, and reduced cost of components and construction2. Fabrication is easier than that for screw retained prostheses, because traditional prosthetic techniques are followed.

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and there is no need for special training of laboratory technicians. Restorations of implants with a divergence of less than 17 degree are also easier with cement-retained restorations.

The greatest disadvantage of CISR technique is lack of reliable means of retaining and then retrieving the superstructure for routine care and maintenance. Retrievalability is highly desirable for cleaning and it facilities evaluation for mobility ailing implants. Consequently, the selection of luting agents is very important for CISR. The mechanical properties of luting cements are an important criterion when selecting luting cement. The probability of early tensile failure is reduced with use of stronger cements; hence, the chance of clinical success is increased. Mechanical factors, such as resistance/retention form, height, distribution and number of abutments, accuracy of superstructure fit, as well as maxillary versus mandibular arch, will strongly influence the amount of cement retentiveness required for a given restoration. A number of references that compare the retentiveness of the cements commonly used in this technique are available.

The aim of this study was to evaluate the retentive strengths of dental cements that have been adapted in full arch implant fixed prosthesis. The null hypothesis was that the retentive strengths of dental cements that have been adapted in full arch implant fixed prosthesis would show different results as adapted implant prostheses.

Material and Methods

Test specimens consisted of 1 maxillary acrylic resin model with inserted 8 ITI implants (Institut Straumann AG, Waldenburg, Switzerland) and solid titanium abutments (Fig. 1). The base metal alloy’s (Rexillium III; Pentron Laboratory Technologies, Wallingford, Conn.) cast onto abutments formed an attachment mechanism for testing (Fig. 2). 4 permanent and 3 provisional cements were tested in this study (Tab. 1).

Table 1. Provisional and permanent luting cements used in the study

<table>
<thead>
<tr>
<th>No</th>
<th>Brand name</th>
<th>Cement</th>
<th>Cement type</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adhesor (A)</td>
<td>Zinc phosphate cement</td>
<td>Permanent</td>
<td>Sofa Dental, Czech Rep.</td>
</tr>
<tr>
<td>2</td>
<td>Adhesor Carbofin (AC)</td>
<td>Zinc polycarboxylate cement</td>
<td>Permanent</td>
<td>Sofa Dental, Czech Rep.</td>
</tr>
<tr>
<td>3</td>
<td>Kavitan cement (KC)</td>
<td>Glass ionomer cement</td>
<td>Permanent</td>
<td>Sofia Dental, Czech Rep.</td>
</tr>
<tr>
<td>4</td>
<td>Multilink (M)</td>
<td>Self cure resin composite cement</td>
<td>Permanent</td>
<td>Ivoclar, Vivadent, Schaan, Liechtenstein</td>
</tr>
<tr>
<td>5</td>
<td>Cavex (C)</td>
<td>Zinc oxide eugenol free</td>
<td>Provisional</td>
<td>Cavex, Haarlem, Holland</td>
</tr>
<tr>
<td>6</td>
<td>Relyx Temp (RT)</td>
<td>Zinc oxide eugenol free</td>
<td>Provisional</td>
<td>3M ESPE, Seefeld, Germany</td>
</tr>
<tr>
<td>7</td>
<td>Premier Implant Cement (PI)</td>
<td>Non-eugenol temporary resin cement for implant retained crowns</td>
<td>Provisional</td>
<td>Premier, Hannover, Germany</td>
</tr>
</tbody>
</table>
An artificial mandible composed of self-polymerizing acrylic resin resembling edentulous mandible was produced. 8 ITI implants were placed in central incisor, canine, second premolar and second molar regions at both sides using a surveyor according to paralleling criterion in a self-polymerizing acrylic resin. Solid titanium abutment 5.5 mm in height was placed on each implant and torqued at 35 Ncm. The abutment was supplied with a prefabricated burnout caps that snap onto the abutment analogue. This cap is produced to provide a defined cement gap between crown and the abutment, hence eliminating the need for die spacer. A tiny lip on the margin of the cap provided the snap-on mechanism. Then wax loops were added to the occlusal surface of the restorations to allow for subsequent retention testing. The entire superstructure was invested in phosphate-bonded investment (Hi-Temp; Whip Mix Co, Louisville, KY) and casted with Rexillium III base metal alloys in the usual manner. The specimens were then retrieved from the casting rings, the investment materials were cleaned with a steam cleaner (Pro-Craft II Steamer Cleaner; Ivoclar North America, Amherst, NY), and the inner surface of the copings was inspected for surface irregularities with a stereomicroscope (Model BM, 38834; Meiji Techno, Tokyo, Japan) at 10 magnification and adjusted with a #1/2 round carbide bur. Each casting was assigned to implant-abutment assembly, and silicone disclosing medium (Fit Checker; GC Europe, Leuven, Belgium) was used to achieve the best possible fit. Cements were mixed according to manufacturers’ recommendations and applied on the axial surface of castings to minimize hydrostatic pressure during seating. Then, the specimens were cemented on the solid abutments with a load of 5 kg maintained for 10 minutes according to ADA specification No:964. Excess cement was cleaned off using a scaler. Mixing and cementing procedures were carried out at room temperature.

After cementation, implant-abutment-casting assemblies were stored for 24 hours at 37°C in 100% humidity environment. The specimens were then subjected to a pull-out test (tensile test) using universal testing machine (Instron 3345 Tester; Instron. Corp, Norwood, MA) at a crosshead speed of 0.5mm/sec, recording the maximum tension value (Fig. 3). Each measurement was repeated 3 times after sufficient time intervals. The components of the specimen were cleaned from cement residues after each tensile test; the residual cement was mechanically removed with a hand instrument. After removing the cement residues, the specimens were cleaned with self-cure acrylic resin solution (Removal-on-1; Premier Dental Products Company, Norristown, PA). Sand blasting, high and low speed air-routers were avoided in the cleaning process of the cement residues to prevent any change in the structure of the castings and the abutments. The load required to de-cement the prosthesis was recorded with Newton standard and mean value was calculated.

![Figure 3 (a and b). The specimens were subjected to a pull-out test (tensile test) using universal testing machine at a crosshead speed of 0.5mm/sec.](image-url)
1 investigator visually inspected each specimen after separation and estimated the percent of the surface of the abutment without cement.

A 1-way ANOVA and a post hoc least square differences LSD test were done at confidence interval of 95%.

Results

Mean tensile forces required to separate the castings from the abutments, for all cements, are mentioned in Table 2. C showed the least retention, and KC provided the highest retention. There were statistical significant differences between tensile bond strength values of all the cements (P<0.0006). Comparison between A, AC, C and RT cement was performed, the statistical significance value was set at P<0.015 (Tab. 2).

Table 2. Mean cement failure load (N) and result of LSD test

<table>
<thead>
<tr>
<th>Cement type</th>
<th>Mean ± SD</th>
<th>Min.</th>
<th>Max.</th>
<th>LSD test</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>83.55 N ± 29.85</td>
<td>46.1520 N</td>
<td>139.3170 N</td>
<td>A</td>
</tr>
<tr>
<td>RT</td>
<td>153.4 N ± 60.34</td>
<td>59.732 N</td>
<td>221.936 N</td>
<td>A</td>
</tr>
<tr>
<td>PI</td>
<td>335.5 N ± 91.65</td>
<td>177.7980 N</td>
<td>415.9880 N</td>
<td>B</td>
</tr>
<tr>
<td>A</td>
<td>256.1 N ± 51.21</td>
<td>176.8170 N</td>
<td>316.2890 N</td>
<td>C</td>
</tr>
<tr>
<td>AC</td>
<td>401.3 N ± 120.1</td>
<td>262.3670 N</td>
<td>586.8370 N</td>
<td>D</td>
</tr>
<tr>
<td>KC</td>
<td>424.6 N ± 163.1</td>
<td>313.7000 N</td>
<td>655.0980 N</td>
<td>D</td>
</tr>
<tr>
<td>M</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

* Same letter denotes that groups were not significantly different from each other (p>0.05)
** No values were calculated

Among the provisional cements, C showed the least retention, while RT had better results for retention (Tab. 2). PI showed the highest retentive value. Post Hoc Dunn’s multiple comparison tests within the cement subgroups revealed that there were significant differences between C and PI, and between RT and PI (P<0.01 and P<0.05, respectively). There were no significant differences between C and RT (P > 0.05).

Among the permanent cements, KC showed the highest retentive results, and A showed the least. The statistical significance in this group was set at P<0.039. Post Hoc Dunn’s multiple comparison test within this cement group (Tab. 2) revealed significant differences between A and KC, and between A and AC (P<0.05). There were no significant differences between KC and AC (P<0.05).

For all of the cements and all of the test conditions, minimal cement adhered to the abutments after dislodgement. Thus, cement failure was primarily adhesive or at the abutment/cement interface.

Discussion

In this in vitro study, cement failure was evaluated by using full arch implant fixed prosthesis cemented to 8 implant abutments with 1 of 7 luting protocols using tensile loading. Laboratory technician with easy and predictable procedures provided ITI solid abutment plastic burnout cap system. A space was manufactured between the abutment and the plastic cap, hence eliminating the need for die spacer. The built-in cement space measurement was 20μm, which is consistent with ADA specification NO:96 for ideal cement thickness. The presence of this uniform cement space also decreased the need for casting adjustments.

This study showed that tensile bond strength values of provisional cements, except for PI, were significantly lower than those of permanent cements. Among the permanent cements, glass ionomer cement and zinc polycarboxylate cement exhibited higher tensile bond strength value than zinc phosphate cement. Breeding et al17 compared 3 provisional luting agents, glass ionomer cement and 2 resin luting agents. They found that the 3 provisional cements were less retentive than the glass ionomer and 2 resin luting agents. Pan and Yin9 compared 2 provisional luting agents and 4 definitive cements. They found that the provisional cements were much less retentive than definitive cements. These findings matched the result of the present study, which demonstrated that provisional cements (Cavex and Relyx Temp) were much less retentive than Kavitan Cem glass ionomer cement, Adhesor Carboline polycarboxylate cement and Adhesor zinc phosphate cement.

Racher et al18 found that resin cement demonstrated the highest mean retentive strength when compared with zinc phosphate cement and resin-reinforced ionomer cement. In this study we also used multilink resin cement. During the test, no values were obtained, the load cell was probably not appropriate, so that this cement might not be suitable for testing in full arch implant fixed prosthesis study design. Our study is also in agreement with other, who showed that the retentive strengths of the provisional cements are lower than those of the definitive cement7,9,12,17. The group of cements tested in this study ranged from common dental cements generally designed for permanent cementation to those considered for provisional cementation, and included some specifically designed for implant restorations6. It should be reasonable to expect that those cements using as permanent luting agents, such as resin cement, glass ionomer cement, polycarboxylate cement and zinc phosphate cement, would be at the top of the retention list.
Mansour et al\textsuperscript{5} found that the rank order of retentiveness differed when tested on implants or natural teeth. This was also found to be true in our study. Preconceived expectation generally held true, with the finding that PI cement, which is non-eugenol provisional resin cement for implant retained crowns, showed higher strength bond value than zinc phosphate cement. Thus, the null hypothesis was accepted, that the retentive strengths of dental cements that have been adapted in full arch implant fixed prosthesis would show different results as adapted implant prostheses. Hence, the retentive strength of PI was significantly higher than all cements except Zinc polycarboxylate cement and Glass ionomer cement tested in this study. It was interesting that PI also exhibited a higher tensile bonding strength values than zinc phosphate cement. This could be explained by the fact that zinc phosphate cements provide casting retention by micromechanical interlocking into the casting and the abutment surface irregularities\textsuperscript{14}. The high strength of the PI is similar to permanent cements, and might be due to silicon contains, which add to the adhesion strength of the cement. Manufacturer advocated that during the application of PI, lubricant could be applied on the abutments; therefore, it would be easier to retrieve the prosthesis if needed in future. It is not known would PI with the KJ Jelly provide sufficient retention so that the patient would have to return for recommendation at an unexpected time. In general, however, the rank order in this study is in agreement with the rank order of similar studies\textsuperscript{5,9,13,18}.

Mansour et al\textsuperscript{5} observed that the goal of studies such as these is not to discover the “best” cement. Rather, the goal is to provide “the ranking order of the cements in their ability to retain the casting”. The clinician’s opportunity to select from the retentiveness of various cements and apply it in an escalating fashion allows a sense of comfort and control when releasing the patients after insertion of crown\textsuperscript{3}.

This \textit{in vitro} investigation had several limitations that must be addressed in future studies:

No thermal cycling test and cycling fatigue test was used, so the effects of degradation were not take into account in this study. Therefore, cyclic fatigue stress, thermal cyclic testing should be considered in future studies;

Each abutment/superstructure combination was used 3 times with cleaning and reabrading of the superstructure interior accomplished between each cement sample. This raises the question of consistency of fit being affected by the cleaning process and influencing the data;

Castings in this study were made from a base metal alloy (Rexillium); if a precious metal alloy or some other material had been used, results might be different.

Conclusions

It is clearly recognized that the retentive force mainly depends on the properties of the cement. The use of appropriate cement for a specific restoration type may reduce cement failures. However, the clinical outcome of different cements used for different restorations has not been investigated. The future studies are needed on this subject.

References


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