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RESEARCH ARTICLE

Retention properties of six different luting cements on titanium surface

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ABSTRACT

Objectives: With conflicting results in the literature and various manufacturer recommendations, implant restorative cements can provide inadequate retention on implants, especially short or single implants. The aim of this study was to evaluate and compare the retentive properties of six different implant restorative cements on titanium surface.

Materials and Methods: A total of 120 titanium rods of specimens (10 mm in length and 12 mm in diameter) were divided into 6 experimental groups (n=20) and six different cements were compared: Adhesor (A), Adhesor Carbofine (AC), Cavitan Cem (CC), Meron (M), Implacem (IM), and MIS Crown Set (MIS). Specimens were subjected to shear bond strength test by a universal testing machine with a crosshead speed of 1 mm/min. The data were analyzed with Kruskal-Wallis and Mann-Whitney U tests (α=0.05).

Results: The highest mean bond strength was observed in specimens of group MIS, and followed by specimens of group AC. The adhesive failure mode was predominantly observed in all groups.

Conclusions: Different cements on titanium surfaces provide different retention levels. Resin cement is the cement of choice for the definitive non-retrievable cementation of crown copings to implant abutments.

Keywords: Luting cement, titanium, implant, shear bond strength.

INTRODUCTION

Dental implants are an effective and popular option for replacing missing teeth and form an important part of mainstream dental practice today.[1-3] Restorations placed on the implants are generally classified as either screw or cement retained.[2,4-6] Screw-retained prostheses have the advantage of retrievability over cement-retained restorations.[6,7] Simple retrieval is particularly important if complications arise, such as abutment screw loosening.[8] Furthermore, Weber et al.,[9] who compared periimplant soft tissues of cement-retained and screw-retained restorations, reported that poorer soft tissue health associated with cement-retained restorations. Nevertheless, cement-retained prostheses are suggested to have a higher potential of passive fit in light of the fact that the cement space between retainer and abutment could compensate for minor prosthesis misfit.[10] Other advantages include enhanced esthetics, less porcelain failure, reduced technique sensitivity both in the clinic and laboratory,[11,12] adequate restoration outline, easy cleaning,[5] and ability to optimize occlusal interdigitation.[8] Several factors influence the retention of cement-retained implant-supported prostheses including taper, length, width, surface area, and number of implant abutments, surface finish or roughness[6,8] accuracy of superstructure fit, splinting of multiple units, and strength properties of

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the cast metal superstructure.[7,8] Type of luting agent and variations in its viscosity also affected the retentiveness of definitive restorations.[3,4,8,13-16]

Dental luting agents provide the link between a fixed prosthesis and the supporting structure, prepared tooth or implant abutment.[17] Cementation is a vitally important stage for successful dental prosthetic work. Resin, glass ionomer and zinc oxide cements are some of the more readily available and widely used materials for traditional crown and bridge procedures. These types of cements are now employed clinically in cementing crowns to implant abutments. In cementing crowns to implant abutments, luting agents are required to act in a different manner to oppose two metallic surfaces whereas with natural teeth one surface normally consists of enamel, dentine or restorative material.[1] Several studies have investigated the retentive strength of cements used for bonding metal or ceramic restorations to tooth structure. According to a literature review, the most common technical complications of cement-retained implant-supported fixed restorations were loss of retention (16.8%), particularly when temporary cements and short abutments were used.[18] Therefore, Akin et al.[19] researched on the effect of various surface treatments including sandblasting, Nd:YAG and Er:YAG lasing on the retention properties of titanium to implant restorative cement. However, limited studies are available on the retention of implant crowns to metal abutments and there is little scientific evidence for the type of cement selected for implant restorations. Therefore, the purpose of this study was to evaluate and compare the retentive properties of six different luting cements (a zinc phosphate, a zinc polycarboxylate, two different glass ionomers, and two different resin cements) used for implant prostheses. The null hypothesis tested was that there is no difference in the shear bond strength provided by different luting cements to titanium surface.

MATERIALS AND METHODS

Titanium bars (Straumann AG, Basel, Switzerland) were sectioned with a lathe into 120 specimens, 10 mm in length and 12 mm in diameter. All specimens were machine cut from long metal rods to the same specified dimensions. Width and length were confirmed with a digital caliper (Altas 905; Gedore-Altas, Istanbul, Turkey) accurate to 0.01 mm. To attain a standardized surface, titanium specimens were polished consecutively with 600, 800, and 1200-grit silicon carbide papers (English Abrasives, London, England) under water-cooling on a polishing machine (Phoenix Beta Grinder/Polisher, Buehler, Germany). Titanium specimens were surrounded by a sellotape to prevent overflowing of the cements (Figure 1).

Figure 1. Titanium specimens were surrounded by a sellotape.

They were randomly divided into 6 experimental groups (n=20) according to different luting agents applied. Six types of cements were used (Table 1) and they were mixed in accordance with the directions supplied by the manufacturers and then cements except resin ones loaded into a 2ml plastic syringe (Hayat Syringe, Hayat Medical Equipment, Istanbul, Turkey)

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within the respective specimen's working time. Resin cements are already in plastic syringes and have mixing tips. Cements were applied on the titanium surfaces from

Table 1. Luting cements used in study.

Product Name	**Manufacturer**	**Type**
Adhesor (PH)	Spofa Dental, Markova, Czech Republic	Zinc phosphate
Adhesor Carbofine (PC)	Spofa Dental, Markova, Czech Republic	Zinc polycarboxylate
Cavitan Cem (GIC)	Spofa Dental, Markova, Czech Republic	Glass ionomer
Meron (GIM)	Voco, Vuxhaven, Germany	Glass ionomer
Implacem (RI)	Equinox Medical Technologies B.V., Zeist, Holland	Resin
MIS Crown Set (RM)	MIS Implant Technologies Ltd, Shlomi, Israel	Resin

The letters in the parenthesis are referred to group names.

the syringe to minimize air voids. After cementation, specimens were stored in distilled water at 37°C for 24 hours. The sellotapes were then carefully removed. The specimens were mounted in the custom jig of a universal testing machine (Lloyd LF Plus, Ametek Inc, Lloyd Instruments, Leicester, UK), and load was applied to the adhesive interface at a constant crosshead speed of 1 mm/min until failure occurred. The maximum force to produce fracture was recorded in *Newtons.* Modes of failure were visually determined for every specimen after testing and categorized into one of the following types: *adhesive failure;* refers to total separation at the interface between the cement and titanium, *cohesive failure* refers to tear within the cement, *mixed failure* refers to both (Figure 2).

The fractured specimens were examined under a stereomicroscope (SMZ 800, Nikon, Tokyo, Japan) at 40X magnification to evaluate the fracture pattern. All observations were conducted by one person. The mean value and standard deviation of the specimens were statistically evaluated by Kruskal-Wallis and Mann-Whitney U tests (α=0.05).

Figure 2. Representative specimen for mixed failure.

RESULTS

Kruskal-Wallis tests results for shear bond strength measurements of the groups are summarized in Table 2 (F=67.29, p<0.001). Analysis of the data revealed that the highest mean bond strength was observed in specimens of group RM, and followed by specimens of group PC. There were no significant differences between groups PH and GIM (p=0.126), and groups GIC and RI (p=0.121).

Modes of failure are presented in Table 3. The analysis of failure after the shear test revealed that the adhesive failure mode was predominantly observed in all groups. Group RI specimens were demonstrated 100% adhesive failure. Mixed failures were detected in groups PC, GIC and RM (30%, 5%, and 15%, respectively), whereas cohesive failures were seen only in groups PC and GIC (10% and 5%, respectively).

DISCUSSION

The results obtained in this study clearly demonstrate that retention of the cements to titanium surfaces was not similar, by which the hypothesis was rejected. Furthermore, it was found that MIS resin cement and polycarboxylate cement showed higher bond strength to titanium surface than other cements. This result in accordance with the study of Mansour et al.[10] Moreover, consistent with the present study, Akça et al.[20] and Sheets et al.[7] found polycarboxylate cements had

Table 2. Mean shear bond strength (MPa) and SD of each group.

Groups	Mean	SD
Group PH	38.26[a]	6.68
Group PC	193.4[b]	18.8
Group GIC	108.09[c]	21.77
Group GIM	31.05[a]	8.88
Group RI	123.22[c]	20.38
Group RM	404.6[d]	35.36

Groups with same superscripted letters not significantly different (p>0.05).

Table 3. Mode of failures of groups for each specimen.

Groups	n	Adhesive failure	Cohesive failure	Mixed failure
Group PH	20	4 (20%)	—	—
Group PC	20	12 (60%)	2 (10%)	6 (30%)
Group GIC	20	18 (90%)	1 (5%)	1 (5%)
Group GIM	20	8 (40%)	—	—
Group RI	20	20 (100%)	—	—
Group RM	20	17 (85%)	—	3 (15%)

The letters in the parenthesis are referred to failure ratio.

higher retentive strengths than glass-ionomer, zinc phosphate, or provisional cements. In addition, Dudley et al.[1] reported that resin cement exhibited higher retention than glass-ionomer and temporary cements. However, Montenegro et al.,[21] who investigated retention of zinc phosphate, glass-ionomer, temporary and resin cements for implant restoration, advocated that zinc phosphate cement had the highest bond strength. Clayton et al.[22] also found that zinc phosphate presented the highest retention values when compared with the other cements, including resin cements. The results of the present study contradict those of Montenegro et al.[21] and Clayton et al.[22]

The permanent cements are more frequently used in cementing implant supported prostheses, and reports of their use are more common than those of temporary cement.[23] Implant supported prostheses may be definitively cemented with temporary cements, so that it is possible to remove the prosthetic part, should there be any problem with the implant pillar. However, the tensile strength of the cements has to be sufficient to resist lateral and vertical forces during function. According to Akca et al.,[20] temporary cements should preferably be used in cases of prostheses with multiple implants. Moreover, they advocated the idea that for critical single-unit cases in the posterior region (short abutments), high retentive cements should be used. On the other hand, it is desirable that the cement be as radiopaque as possible while demonstrating other required physical properties. Removal of excess cement may be facilitated if it can be detected radiographically. Knowledge of the different radiodensities of cements used for implant prostheses may assist the clinician in selecting appropriate cement. Wadhwani et al.[2] reported that resin cements, especially implant specific cement have higher radiopacity than temporary cements, zinc phosphate and glass-ionomer cements. Therefore, in the present study, only permanent cements were used to evaluate bond strength to titanium surface.

The machined abutment surface was not modified with any preparation and was therefore relatively smooth. Hereby, titanium specimens were polished with silicon carbide papers obtain smooth surface as machine abutment. This could have decreased cement-titanium micromechanical interlocking, leading to decreased cement retention values. This explanation can support adhesive failures in all groups.

One of the limitations of this study was that *in vivo* conditions were not simulated by using long term water storage and thermocycling. Thus, future investigation should focus on to determine retention properties of different resin cements on titanium after long term water storage and therocycling.

CONCLUSION

Within the limitations of this study, different cements which are bonded to titanium surfaces provide different retention levels. Resin cement is the cement of choice for the definitive non-retrievable cementation of crown copings to implant abutments.

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The author reports no conflicts of interest.

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