Original Article

Effect of Three Types of Temporary Luting Cements and Abutment Surface Sandblasting on Retentive Strength of Implant-Supported Fixed Prostheses

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Abstract

Background and Aim: Achieving appropriate retention and easy retrieve ability at the same time is challenging in implant-supported fixed partial dentures (FPDs). Researchers have always been in search of a temporary cement to improve the retentive strength.

The aim of this in vitro study was to evaluate the effect of three different temporary cements and sandblasting of the abutment surface on the retentive strength of implant- supported fixed prostheses.

Materials and Methods: In this experimental study, 10 DIO implant analogues were mounted in acrylic resin. Twenty abutments were divided into two groups of 10. The abutments in group one were used in their intact standard form while those in group two were sandblasted. Sixty metal copings were fabricated and cemented on abutments of each group using three types of temporary cements namely Kerr, Provy and GC. Specimens were subjected to a universal testing machine to measure their retentive strength. The results were analyzed by two-way ANOVA and pairwise comparison was performed usingTukey's post-hoc test.

Results: The retentive strength of TempBond (Kerr) with sandblasted abutments was significantly higher than that of the other two cements ($p<0.001$). In standard abutments, Provy had slightly but not significantly higher retentive strength. The lowest values in both abutment groups were obtained by GC cement.

Conclusion: Kerr TempBond cement with sandblasted abutments yields the highest retentive strength.

Key Words: Retention, Cement, Surface properties, Implant-supported prosthesis

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Introduction

Implant-supported fixed prosthesis is a successful modality for replacement of the lost teeth with predictable results [1,2]. An important success criterion for this treatment is adequate retention of prosthesis over the abutment [3]. Retention must be high enough not to allow displacement during function but at the same time, it should allow restoration retrieval if required without damaging the prosthesis or implant [4]. The prostheses can be screwed or cemented to the abutments [5]. The main advantage of screw-retained prostheses is their easy retrieval whenever required [6].

However, presence of a screw hole may cause problems in occlusion, porcelain strength and esthetics [5]. Also, achieving passive fit is more difficult in this method and active fit applies excessive load to the screw and results in greater transfer of load to the implant-bone interface, which may eventually lead to screw fracture or compromise implant osseointegration [7]. Screw loosening is among the most common problems of screw-retained prostheses [8]. In contrast, cement-retained prostheses are more commonly used due to greater advantages and less complications [1,9,10]. Higher esthetics, more balanced occlusion, easier fabrication, lower cost and passive fit are among the advantages of cement-retained prostheses [5].

Retention of cement-retained restorations depends on several factors [11]. Abutment-related factors include abutment height, contact area with prosthesis, taper of axial surfaces and surface roughness [4]. Prosthesis-related factors include prosthesis-abutment fit, roughness of the internal surface of framework and type of alloy used in prosthesis. Cement-related factors include type of cement, presence of vent, viscosity, load applied for seating the restoration and duration of load application for seating [8,11,12]. Selection of the cement must be based on the level of retention required, the need for future retrieval, easy removal of excessive cement and cost [13].

Two types of cements may be used: permanent and temporary. For resolving potential complications related to implant-supported prostheses such as screw loosening (which is relatively common), the prosthesis usually needs to be retrieved without damaging the implant or abutment. Thus, use of temporary cements is often recommended [14]. However, several methods are used to enhance the retentive strength of these cements [15].

Roughening the abutment surface is among these techniques which increases the surface area and causes micromechanical retention [14]. Surface roughening can be done by use of high-speed burs or sandblasting.

Several studies have evaluated factors affecting the retention of implant-supported fixed prostheses. Different cements yield different retentive strengths. However, the effect of sandblasting the abutment with the use of different cements has been less commonly evaluated [13,16].

This study aimed to assess the retentive strength of implant-supported prostheses using TempBond by Kerr, Provy and GC Freegenol temporary cements with standard and sandblasted abutments.

Materials and Methods

In this experimental study, 10 SM implant analogues (FAF4512, DIO, Korea) were separately mounted in acrylic resin in molds measuring 20×30 mm. A surveyor was used to ensure their perpendicular position relative to the horizontal plane. Twenty cement-retained abutments (SAC4815T, II) with 5.5mm length and 4.8mm diameter were assigned to two groups of 10. Group one was used with no surface modification in the standard machined form. Group two abutments were sandblasted using 50μ aluminum oxide particles for 15 seconds with 2.5 bar pressure at 10mm distance.

Group one abutments were screwed onto the analogues using a torque wrench with 35Ncm torque recommended by the manufacturer. The abutment screw hole was filled with composite. Sixty metal copings were fabricated for retentive strength testing as follows: The prefabricated plastic coping of Dio system (SASP 4810SII, DIO, Korea) was placed over each abutment. A wax ring was formed over the plastic coping using inlay wax (Figure 1). After spur placement, wax model was flasked and cast using base metal alloy (T3K, Ticoniumi, Korea). After cutting the spur, finishing and polishing, adaptation of copings over the abutments was assessed using an explorer under a magnifier.

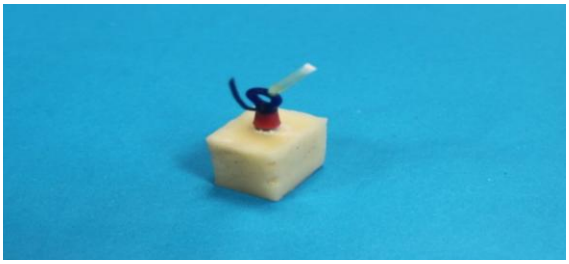

Figure 1. The sprued wax pattern

Samples were randomly divided into six groups of 10. In the first phase, 10 abutments in group one (standard) were screwed into the analogues. Ten copings were cemented using TempBond (Kerr) according to the manufacturer's instructions. Load was manually applied for 10 seconds and after eliminating excess cement, 5kg load was applied by the manufacturer for 10 minutes by Zwick machine until final setting of cement.

Samples were immersed in artificial saliva for cyclic loading and thermocycling. Samples were

first incubated in 100% humidity at 37°C for 24 hours and were then subjected to thermocycling between 5-55°C for 2000 cycles.
Samples were subjected to cyclic loading by 3 million cycles with 75N load and 1.2Hz frequency corresponding to three years of clinical service [17].

Measurement of retentive strength:
Samples were fixed in a universal testing machine (Zwick/Roell, Korea). A metal hook connected to the upper compartment of the machine was connected to the ring designed on the coping and then tensile load was applied at a crosshead speed of 0.5 mm/min (Figure 2).
Load at separation of metal coping from the abutment was recorded by a computer. Mode of failure in each specimen was assessed under a magnifier. Mode of failure was categorized into four groups of adhesive at the abutment-cement interface,
adhesive at the coping-cement interface, cohesive within the cement and mixed.
Abutments were separated from the analogues, washed with water and placed in an ultrasonic bath containing an irrigating solution (SYMPRO Fluid Universal) for 10 minutes.
Afterwards, samples were washed with water and ethanol and dried. The same procedures were performed using Provy and GC cements. Second group abutments (Sandblasted) were screwed into the analogues and underwent the above-mentioned procedures. The results were recorded.
All procedures were performed by the same operator. Data obtained from retentive strength testing were subjected to Kolmogorov Smirnov test to assess their distribution in each group.
Two-way ANOVA was used to assess the effects of type of cement and surface properties of abutments as well as the interaction effect of the two on the retentive strength. Pairwise comparison of groups was done using post-hoc Tukey’s test.

Results
The retentive strength values for the groups are shown in Table 1. For Kerr cement, the retentive strength was significantly higher in the sandblasted group compared to the standard group ($p<0.001$).
For GC cement, the retentive strength was slightly,

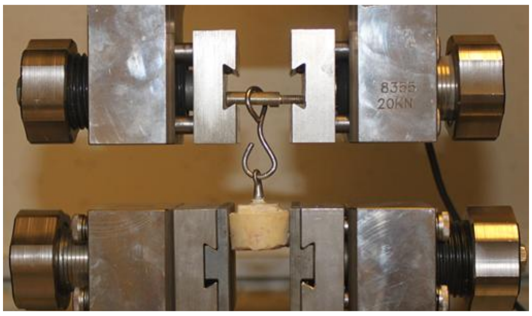

Figure 2. Measurement of tensile strength

but not significantly, higher in the sandblasted group compared to the standard group. For Provy cement, the retentive strength in the standard group was slightly, but not significantly higher than the sandblasted group. In standard abutment group, the highest retentive strength belonged to Provy cement, but its difference with Kerr and GC cement was not significant. In sandblasted abutment group, retentive strength of Kerr cement was significantly higher than that of GC and Provy cements ($p<0.001$). The frequency of modes of failures in different groups is shown in Table 2. In Kerr cement, the mode of failure was mainly adhesive at the cement-abutment interface. In GC cement, mode of failure was mainly cohesive within the cement, and adhesive in some samples. In Provy cement, mode of failure was mainly adhesive at the interface of coping and cement.

Discussion
The type of cement plays an important role in success of implant-supported cement-retained fixed prostheses [18]. Permanent cements are not usually recommended due to difficult retrieval of restorations and risk of damage to the prosthesis, abutment or fixture during retrieval [19, 20].
Studies have shown that some temporary cements provide adequate retention and can be used instead of permanent cements [21]. Retention of temporary cements can be enhanced by several techniques such as increasing the surface roughness of abutments by sandblasting. Sandblasting eliminates the impurities, roughens the surface, increases the contact area and creates micromechanical retention [22].
In this study, the retentive strength of three

Table 1. The mean and standard deviation of retentive strength in Newton in different groups

Type of abutment / Type of cement	Standard group	Sandblasted group
Kerr	35/9±10/5	112/7±15/3
GC	30/2±9/0	30/2±9/0
Provy	39/2±9/7	36/7±8/9

Table 2. The frequency of modes of failure in different groups

Type of cement /abutment	Mode of failure	Adhesive at the cement-abutment interface	Adhesive at the cement-coping interface	Cohesive within the cement	Mixed
Kerr/Standard	6	1	1	1	2
Kerr/Sandblasted	5	2	1	1	2
GC/Standard	0	1	7	7	2
GC/Sandblasted	0	2	6	6	2
Provy/Standard	2	4	3	3	1
Provy/Sandblasted	2	5	2	2	1

commonly used temporary cements with the use of standard and sandblasted abutments (with 50μ aluminum oxide particles) was evaluated.
Sandblasting systems use aluminum oxide particles measuring 30-250μ in size [23]. We used 50μ par ticles since most previous studies used 50μ particles. The retentive strength of Kerr cement with use of sandblasted abutments was significantly higher than that of Provy and GC Freegenol cements. However, for standard abutments, no difference was noted in retentive strength of the three cements.
In a study by Nejatidanesh et al, in 2012 on standard abutments, no significant difference was noted in the retentive strength of Kerr and other temporary cements [12]; these results are in line with our findings.
In a study by Farzin et al, two temporary cements (Kerr and Dycal) were compared using standard straight abutments and abutments withthree walls (one axial wall was removed). They reported that the retentive strength of Kerr cement was lower than that of Dycal and was not influenced by the shape of abutment. However, in Dycal group, the retentive strength of abutments with three walls was higher, which was probably attributed to the participation of internal abutment walls in retention and consequently increased contact area and higher surface roughness of these walls [24].
They showed that each clinical case requires a combination of a particular type of cement and abutment characteristics, which is in line with our findings.
Tabakhian and Nouri in 2012 evaluated three types of temporary cements and reported lower retentive strength of Kerr cement compared to two other cements [25]. These results are in contrast to our findings, which may be due to the differences in the methodologies. For instance, they only used standard abutments and did not perform sandblasting. Also, artificial aging (thermocycling and cyclic loading) was not performed.
Ongthiemsak et al, in 2005 and Ga Ray et al, in 1999 showed that cyclic loading significantly decreased the retention of restorations in vitro [17,26]. Michalakis et al, in 2007 showed that thermocycling significantly decreased retention of restorations with temporary cements [13]. Thus, aging was performed in our study to better simulate the oral clinical environment. Michalakis et al, in 2007 also demonstrated that retentive strength of Kerr cement increased more than that of GC Freegenol after sandblasting the abutment

surface; despite differences in the methodologies, their results were similar to ours.

Kim et al, in 2006 showed that retentive strength of Kerr cement was lower than that of three other temporary cements [16]. Difference between their results and ours may be explained by the different methodologies. For instance, they used temporary crowns, which are totally different from metal copings.

Our study showed that sandblasting the abutment surface enhanced retention. For Kerr cement, this increase in retention was statistically significant.

Juqdev et al. assessed the retentive strength of three types of cements with standard straight and sandblasted abutments [27] and showed that the retentive strength of Kerr cement slightly increased due to sandblasting of the abutment surface while sandblasting significantly enhanced the retentive strength of Retrieve and Premier cements. Their results showed that a combination of several factors such as type of abutment, type of cement and surface properties of the abutments affects the retention. All these factors must be considered for each case.

Several studies by Sahu et al, [4] Ghanbarzadeh et al, in 2012 [28], Hafezghoran et al, in 2008 [22], De Campos et al, in 2010 (29), Al-Hamad et al, in 2011 [14] and Kim et al, in 2006 [30] confirmed the efficacy of sandblasting and surface roughening for increasing the retentive strength of cements.

Some studies have evaluated surface roughening by high-speed diamond bur. However, due to inability to accurately control or standardize the surface roughness, this method was not evaluated in our study. In addition to sandblasting, some other surface modifications have been recommended as well. But, Kurt et al. [31] showed that sandblasting, although simple, was more effective than etching with CO_2 laser, titanium nitride coating and silicoating [31].

Mode of failure was also evaluated in our study, which can be adhesive at the cement-coping or cement-abutment interface, cohesive or mixed. Clinically, mode of failure affects the simplicity and time required for cleaning the cement remaining on the abutment surface in the oral environment or inside the metal coping [11].

Based on our results, mode of failure in Kerr cement group was adhesive and the cement remained on the metal coping. Mode of failure was cohesive in GCFreegenol and mainly adhesive with the cement remaining on the abutment in Provy cement group. Thus, with respect to the mode of failure and clinical advantage of easy and fast cleaning, Kerr cement is preferred over the other two cements.

Conclusion

1. Sandblasting of the abutment surface increases the retentive strength and is a suitable method to enhance the retention of temporary cements.
2. Kerr cement was superior to GC Freegenol and Provy in terms of retentive strength and mode of failure and yielded a significantly higher retentive strength when sandblasted abutments were used.

The lowest retentive strength belonged to GC Freegenol.

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