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Cement Selection for Cement-Retained Crown Technique with Dental Implants

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Abstract

Purpose: The purpose of this study was to assess and compare the retentive nature of common dental cements that have been adapted for use in the implant abutment cement-retained crown (CRC) technique with those specifically formulated for this purpose.

Materials and Methods: Ten regular diameter implant analogs were embedded in stainless steel disks. Unmodified CRC abutments were attached and torqued to 30 Ncm. Test crowns were waxed and cast with base metal alloy. Castings were fitted, cleaned with aluminum oxide, and steam cleaned prior to application of the cement. The cements used were: (1) Temp Bond, (2) UltraTemp, regular, (3) UltraTemp firm, (4) ImProv with petroleum jelly coating of crown, (5) ImProv without petroleum jelly, (6) Premier Implant with KY Jelly coating of abutment, (7) Premier Implant without KY jelly, (8) TR-2, (9) Fleck's, (10) Ketac Cem Aplicap, and (11) Fuji Plus Capsule. After cementation, assemblies were stored for 24 hours. Each sample was subjected to a pull-out test using an Instron universal testing machine at a crosshead speed of 5.0 mm/min. Loads required to remove the crowns were recorded, and mean values for each group determined. A one-way ANOVA and a post hoc least square difference (LSD) test were done for pairwise comparison at a confidence interval of 95%.

Results: The mean values (±SD) of loads at failure ($n = 10$) for various cements were as follows (N): Ultratemp, regular 358.6 (±38.2) (Group A), ImProv without petroleum jelly 172.4 (±59.6) (Group B), Fleck's 171.8 (±62.2) (Group B), Ketac Cem 167.8 (±69.1) (Group B), UltraTemp firm 158.8 (±62.7) (Group BC), Fuji Plus 147.5 (±69.7) (Group BC), Premier without KY jelly 131.6 (±31.8) (Group BC), ImProv using petroleum jelly 130.8 (±42.5) (Group BC), Temp Bond 117.8 (±48.3) (Group C), TR-2 41.2 (±16.6) (Group D), and Premier with KY jelly 31.6 (±24.8) (Group D). Groups with the same letter were not significantly different.

Conclusions: Within the limitations of this in vitro study, it is not suggested that any one cement is better than another at retaining cement-retained crowns (CRCs) to implant abutments or that a threshold value must be accomplished to ensure retention. The ranking of cements presented is meant to be a discretionary guide for the clinician in deciding the amount of desired retention between castings and implant abutments.

The advantages and disadvantages of restoring dental implants with a cement-retained superstructure are well documented;[1-5] however, universal applicability of the technique is restricted by its most prominent disadvantage, which is the loss in ease of retrievability of the cemented superstructure.[2,4,6,7] This conundrum naturally focuses attention on the choice of cement. On one hand, selection of a cement that is too retentive could lead to damage due to use of aggressive removal techniques; on the other hand, the selection of a cement that is not retentive enough could be a potential source of embarrassment for the patient.[5,8-10] As a result, practitioners who desire retrievability have generally gravitated toward using cements with "soft-access" (sub-maximal) retentive properties.[1,2,8,11]

The most common advantage of the cement-retained crown (CRC) technique is a comfortable familiarity with the clinical and laboratory techniques of conventional fixed dental prostheses, particularly to practitioners accustomed to managing restorations with telescopic prostheses.[11] Other advantages include enhanced posterior esthetics, ability to correct minor casting misfits between superstructure and abutments, and reduced technique sensitivity both in the clinic and the laboratory.[3-5,8] Additionally, the CRC technique becomes the method of first resort when confronted with malaligned implants.[8]

The greatest disadvantage of the CRC technique is the lack of a reliable means of retaining and then retrieving the superstructure for routine care and maintenance. Retrievability is highly desirable for cleaning, and it facilitates evaluation for mobility of ailing implants.[2,4,6] In addition, treatment for periimplant bone loss can be enhanced by removing the superstructure and resubmerging the implant.[6] Mechanical failures are also rectified by retrieving the superstructure. Abutment screw loosening is cited as the most frequent complication of implant-supported crowns and fixed partial dentures (4.5–30.7%; average = 7%).[1,4,7,12-14] Another drawback to the CRC technique is the reported potential for damage due to the inability to retrieve excess cement from implant margins, leading to adverse periodontal problems.[6]

Logically, no single retrievable cement will suffice for all clinical situations. 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.[8-10,15-25] Knowledge of the relative retentiveness of different cements should improve the utility of the CRC technique by offering the clinician a progression of retentive strengths from which to choose.[5,26]

A number of references that compare the retentiveness of the cements commonly used in this technique are available.[8-10,27-30] This study will assess and compare the retentive nature of common dental cements that have been adapted for use in the implant CRC technique and compare them to two cements that are formulated specifically for this purpose.

Materials and methods

Ten regular diameter implant analogs were imbedded into individual 1-inch diameter stainless steel disks. Unmodified abutments, measuring 6.38 mm in height and 5 mm at the base and having a 3° taper, were attached to the analogs and torqued to 30 Ncm using a torque wrench (all Lifecore Biomedical, Chaska, MN) (Fig 1). The abutment screw was covered with a cotton pellet, and the access hole was closed with Cavit (3M ESPE, St. Paul, MN) flush with the occlusal surface of each abutment.

Test crowns were waxed (Slaycris Wax, Portland, OR) directly onto each of the unmodified abutments and sprued. The sprue was left a minimum of 10 mm in length and parallel to the line of draw of the crown to be later used as the mechanism of attaching the crown to the Instron (MTS Systems Corp., Eden Prairie, MN) crosshead. The waxed crowns were invested and cast in a base metal alloy (Rexillium III, Pentron Laboratory Technologies, Wallingford, CT) in the usual manner.

The test crowns were fitted to the abutments using a disclosing powder (Quickcheck, Vacalon, Pickerington, OH) under 3× magnification by one of the participants (JS). The internal surface of each crown was airborne-particle abraded with 50-μm aluminum oxide (Sterngold, Atteboro, MA), and crown internal and abutment surfaces were steam cleaned (Fig 2).

Figure 1 Stainless steel disk containing analog and attached CRC abutment.

The cements used in this study are listed in Table 1. All cements were mixed following the manufacturer's instructions. The only alterations to the established manufacturer's protocols were with the second runs of both Im-Prov, in which the petroleum jelly (Perrigo, Allegan, MI) coating of the crown was eliminated, and Premier Implant cement, in which the KY Jelly (Personal Products Company, Skillman, NJ) coating of the abutment was eliminated. This was done to test the retentiveness of these cements in the absence of surface contamination.

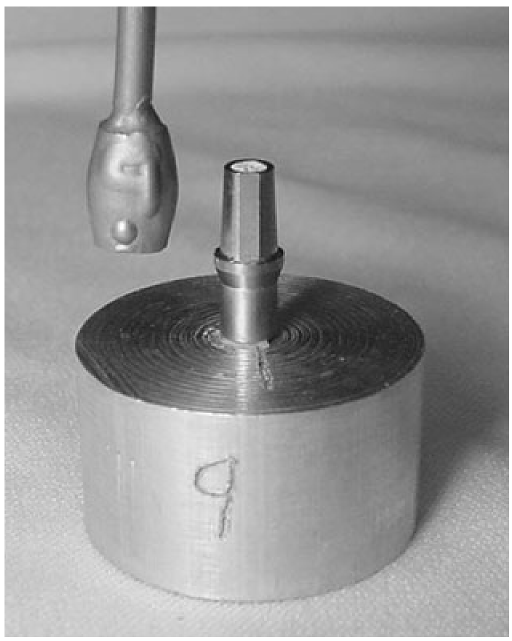

Figure 2 Test crown fabricated to align with CRC abutment.

Table 1 Cements listed by name, type, and manufacturer

Item	Cement name	Cement type	Manufacturer
C1	Temp Bond	Temporary crown and bridge cement, zinc oxide eugenol base	SDS Kerr, Glendora, CA
C2	UltraTemp, temporary polycarboxylate cement (regular set)	Polycarboxylate temporary cement	Ultradent, South Jordan, UT
C3	ImProv, temporary cement (with petroleum jelly coating of crown)	Non-eugenol, acrylic/urethane based temporary cement	Nobel Biocare, Göteborg, Sweden
C4	ImProv, temporary cement (without petroleum jelly)	Non-eugenol, acrylic/urethane based temporary cement	Nobel Biocare, Göteborg, Sweden
C5	Premier Implant cement (with KY Jelly coating of crown)	Non-eugenol, temporary resin cement for implant retained crowns	Premier, Plymouth Meeting, PA
C6	Premier Implant cement (without KY Jelly)	Non-eugenol, temporary resin cement for implant retained crowns	Premier, Plymouth Meeting, PA
C7	TR-2, temporary resin cement	Resin-based, autocure material for interim cementation	Parkell, Farmingdale, NY
C8	Fleck's cement	Zinc phosphate	Mizzy, Inc., Cherry Hill, NJ
C9	Ketac Cem Aplicap	Glass ionomer luting cement	3M ESPE, St. Paul, MN
C10	Fuji Plus Capsule	Radiopaque reinforced glass ionomer luting cement	GC America, Alsip, IL
C11	UltraTemp, temporary polycarboxylate cement (firm set)	Polycarboxylate temporary cement	Ultradent, South Jordan, UT

Crowns were cemented to abutments using a uniform 2-kg load directed down the long axis of the sprue until the cement had set (Fig 3). Excess cement was cleaned off, and the crowns were allowed to set for 24 hours.

The disk assembly was attached to the base component of the Instron unit, and the crown was attached to the crosshead by means of the sprue (Fig 4). The Instron unit was set to a crosshead speed of 5.0 mm/min until complete rupture of the cement bond. Peak load in pounds was measured for each crown removal and converted to Newtons.

Between each run, the residual cement was mechanically removed with a hand instrument, the internal surface of the crown was airborne-particle abraded, and both crown and

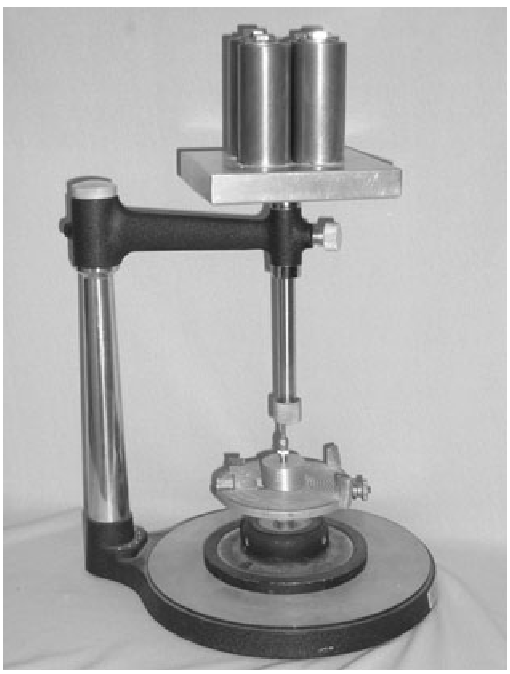

Figure 3 Modified surveyor showing 2-kg weight directed along long axis of implant at cementation.

Figure 4 Disk attached to lower member and crown via sprue attached to upper member of Instron for pull-test.

Table 2 Force to dislodgment one-way ANOVA test

Cement	n	Mean (Newtons)	Standard deviation (Newtons)
C1	10	117.8	48.3
C2	10	358.6	38.2
C3	10	130.8	42.5
C4	10	172.4	59.6
C5	10	31.6	24.8
C6	10	131.6	31.8
C7	10	41.2	16.6
C8	10	171.8	62.2
C9	10	167.8	69.1
C10	10	147.5	69.7
C11	10	158.8	62.7

abutment surfaces were steam cleaned. Aluminum oxide was not used on the abutment surface.

Data were reported in Newtons. A one-way ANOVA and a post hoc least square difference (LSD) test were done for pairwise comparison at a confidence interval of 95%.

Results

Results from the one-way ANOVA test are recorded in Table 2. Rank ordering of the means and grouping of similar materials by significance from the LSD test are presented in Figure 5. Cement C2 (Group A) was significantly higher than all other cements ($p < 0.05$). Cements C4, C8, C9, C11, C10, C6, and C3 (Group B) were all similar ($p > 0.05$) in retention to each other. Cements C11, C10, C6, C3, and C1 (Group C) were also similar ($p > 0.05$). Cements C7 and C5 (Group D) formed the fourth group ($p > 0.05$).

Group A cement was significantly different ($p < 0.05$) than all other groups, having a mean twice that of any other cement. Groups B and C were primarily the same with the addition of C4, C8, and C9 at the upper end of Group B, and C1 (Temp Bond) to the lower end of Group C. These cements form a good middle line contingent of materials. Group D, the C7 and C5 cements, was significantly less retentive, being about one-third to one-fourth that of the Temp Bond.

Discussion

The debate on what type of cement to use for the CRC technique continues. A glance at a typical Internet forum can deliver some insight into the ongoing discussion and the lack of clinical unanimity.[31]

Mansour et al observed that the goal of studies such as these is not to discover the "best" cement. Rather, the goal is to "provide a ranking order of the cements in their ability to retain the castings."[29] 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 patient after insertion of the crown.[5]

The group of cements tested in this study ranged from common dental cements generally designated for permanent cementation to those considered for provisional cementation and included some specifically designed for implant restorations.

One would reasonably expect that those cements generally formulated as permanent luting agents (i.e., zinc phosphate, glass ionomer, and resin-modified glass ionomer) would be at the top of the retention list; however, Mansour et al[29] found that the rank order of cement retentiveness differed when tested on implants rather than on natural teeth. This was also found to be true in this study. Preconceived expectations generally held true, with the one unique finding being Ultra Temp, regular set, a polycarboxylate provisional cement, topping the list.

Likewise, no determination was made as to what constitutes a threshold (minimum) value that provides ample retentiveness. It is not known if the TR2 or Premier Implant cement with the KY Jelly would provide sufficient retention so that the patient would not have to return for recementation at an unexpected time. In general, however, the rank order obtained in this study is in agreement with the rank order of similar studies.[8,9,27–29]

Hebel and Gajjar[5] report the common practice of adding petroleum jelly into the mixture of zinc oxide and eugenol cement in order to reduce its retentive properties. Both of the purposely-designed implant cements used in this study instruct the user to coat either the abutment (Premier) or the crown interior (ImProv) with a light coat of petroleum or KY jelly. Indeed, the lowest retentive values in this study were achieved by one of these two cements (Premier); however, one must consider

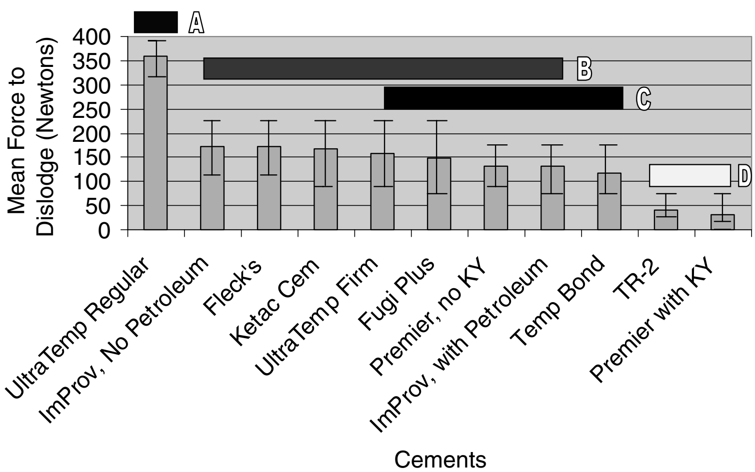

Figure 5 Rank ordering of cements by mean force to dislodgment and grouping of similar cements (Groups A–D) by significance from least square difference test.

the empirical nature that either of these practices injects into the process. Without standardization it is impossible to know what is meant by a layer or a light coat of a material. These same tactics would also work with other cements. When the ImProv and Premier cements were used in their "as dispensed" forms, they were found to be not significantly different than zinc phosphate cement.

Upon review, this in vitro study has some drawbacks:

1. No humidor was used, nor was thermocycling accomplished; so, the effects of degradation that might be seen in the clinical situation over time were not taken into account in the study. Even so, the general concurrence with findings of other studies allows us to conclude that the rank ordering of the cements is valid, if not the absolute values of retention.
2. Each abutment/crown combination was used 11 times with cleaning and reabrading of the crown interior accomplished between each cement sample. This raises the question of consistency of fit being affected by the cleaning process and influencing the data. The same technique used for initial crown fitting was reapplied to each pair at the end of the study and no visual difference in fit was found.
3. Castings in this study were made from a base metal alloy (Rexillium); had a precious metal alloy, titanium, or some other material been used results may have varied.

Conclusion

Retention values of castings to natural teeth versus metallic implants may be totally different for the same cement and cannot always be compared. Within the limitations of this in vitro study, it is not suggested that any one cement variety is better than another at retaining CRCs to implant abutments or that a threshold value must be accomplished to ensure retention. The ranking of cements presented is meant to be a discretionary guide for the clinician in deciding the amount of desired retention between castings and implant abutments.

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