



Effect of Abutment Total Occlusal Convergence and Cement Type on Retention of Cement Retained Implant-Supported Restorations

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Codex : 09/1601

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ABSTRACT

The purpose of this study was to evaluate the effect of abutment total occlusal convergence (TOC), and cement type on the uniaxial tensile resistance to dislodgment of cement-retained, implant-supported metal copings. Six titanium implant abutments were constructed using CAD-CAM technology. Two abutments have TOC 6°, Two abutments have TOC 8°, and Two abutments have TOC 12°. Identical copings were cast to fit each abutment with a loop incorporated that was engaged by the testing unit. The copings were cemented using either a resin-modified glass ionomer (RMGI) (Rely™ X U 200 Automix) or self adhesive resin cement that contained a 10 Methacryloyloxydecyl dihydrogen phosphate (MDP) monomer (Multilink® N). Each of the experimental groups had a unique combination of abutment TOC, and cement. Specimens were aged using a thermocycling unit with water between 5 and 55 degrees Celsius with 15 seconds in each bath and a 5 seconds dwell time, for 540 cycles. A universal testing machine was used to test uniaxial tensile strength. Cement was cleaned using thermal, mechanical, and physical methods, and surface finish was re-established. This procedure was repeated to obtain different measurements for each group. Surface area for each abutment was calculated and used for the calculation of the tensile strength. One way ANOVA followed by pair-wise Newman-Keuls post-hoc tests were performed to detect significance between subgroups. Pair-wise student t-test was performed to detect interaction between variables of significant effect. P values ≤ 0.05 are considered to be statistically significant in all tests. Regardless of the cement type, totally it was found that **Group A** recorded the highest retentive force mean values followed by **Group B** while **Group C** recorded the lowest retentive force mean values. The difference between all groups was statistically significant ($p < 0.05$). Pair-wise Newman-Keuls post-hoc tests showed that the difference between **Group A** and **Group B** was statistically non-significant ($p > 0.05$). Irrespective of convergence groups, totally it was found that **Multilink N** group recorded statistically significant ($p < 0.05$) higher retentive force mean values than **Rely X U200** one.

KEYWORDS

CAD/CAM abutments,
cement retained implant,
RMGI, self adhesive resin
cements

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INTRODUCTION

Implant therapy is a well-documented treatment for replacing missing teeth. The implant-supported prostheses are attached to implant abutments either by cementation, or by retaining screws ⁽¹⁾. Because of the advantages of cement-retained implant-supported restorations, such as passive fit, reduced cost, ease of fabrication, superior esthetic, fewer components, and uncomplicated laboratory technique, these restorations have gained popularity compared to screw-retained restorations. ⁽¹⁾ Even though cement wash outs occur in cement-retained restorations, they do have high clinical success rates. ⁽¹⁾

Retrievability may be a critical aspect of implant-supported restorations because of problems such as loosening or fracture of the abutment screws, mechanical failures, treatment of peri-implant tissues, and evaluation of implant mobility. ^(2,3) Although using provisional cements are considered to achieve retrievability of implant-supported prostheses, retrievability of screw-retained prostheses is more secure than cement-retained ones. ^(2,3)

Retention of implant-supported restorations plays an important role in success of the treatment. Uncemented restorations may cause problems such as inhalation of the restorations, increased bone loss around the implant, prosthesis failure breakage, trauma to antagonistic teeth, food impaction, accumulation of microorganisms resulting in bad odor and soft tissue response. Extra practitioner time and patient embarrassment have also been noted. ^(3,4)

On the other hand, luting agents that are too retentive may damage the osseointegration of the implant during removal of the restoration. ^(3,4)

Behavior of permanent and provisional luting agents in cementation of implant-supported prostheses differs from cementation on natural teeth. In particular, water-based cements such as zinc phosphate, zinc polycarboxylate, and glass ionomer, have shown a wide variety of retentive values, which can sometimes be unpredictable. ^(3,5)

Some authors suggested the use of permanent and provisional cements for luting single-unit and multi-unit implant-supported restorations, respectively. ⁽⁶⁾

Provisional cements have been recommended for restorations that may require intervention, whereas, more retentive cements, such as resin cement, are more appropriate when future retrievability is not necessary. ^(4,7)

The use of different cements, protocols, and implant systems may alter the retentive strength of implant-supported restorations, in addition, different aging processes, such as thermal cycling and mechanical loading, as well as different pretreatment techniques can also affect the retentive strength. ^(4,6,7)

Several factors influence the retention of cemented implant prostheses, including convergence angle, height, and surface roughness of the abutment. ^(4,6,7)

MATERIALS AND METHODS

One implant system was used with tapered screw vent implant analogue with the following dimensions 13mm length, 4.8 mm upper diameter, 4.4 mm apex diameter with 7 degrees taper and CAD/CAM manufactured titanium abutments with 6 mm length, 3.5 mm platform diameter and 0.5 chamfer finishing line.

Two cements were used; Multilink® N self adhesive cement with light curing option, and RelyX™ U200 Auto-mix dual-curing, self adhesive resin modified glass ionomer cement supplied in an auto-mix syringe.

The cad/cam abutments were constructed from a Grade 5 titanium alloy blocks using a 4-axis desktop milling machine.

Implant analogues were seated in a system three epoxy resin blocks simulating bone then the customized abutments were screwed into it with a tapered Hex tool.

Twenty Metal Copings were manufactured from a Non – precious (Nickel- Chromium) dental casting alloy for each group.

The samples of each group were divided into two sub groups according to the type of cement used. The samples of sub group (1) cemented using Multilink N self-adhesive Cement. The samples of sub group (2) cemented using RelyX™ U200 resin modified glass ionomer cement.

The assemblies were stored in 100% humidity and 37° Celsius for 24 hours and then subjected to thermal cycling in water bath at 50 – 55 degree Celsius. After thermo cycling the copings were subjected to uni-axial tensile strength testing using universal testing machine using a load cell of 5 KN.

Data were recorded using computer software (Nexygen –MT Lloyd Instruments).

The residual cement was removed from the abutments surfaces by spoon excavator and then cleaned with a plastic explorer. The abutments were immersed in ultrasonic cleaner containing cement removal agent or 30 minutes and 15 minutes respectively according to the instructions. The same abutment complex was used with new copings within the same cement group to eliminate the possibility of surface contaminations from different cements and avoid interactions between material residuals.

Sixteen times magnification was used to ensure the abutments surfaces were free of residual cement

by using a stereomicroscope. Then abutments were ready for re-cementation with another new metal coping.

RESULTS

Data analysis was performed in several steps. Initially, descriptive statistics for each group results.

Two-factor analysis of variance ANOVA test of significance comparing variables (Convergence group and cement) affecting mean values.

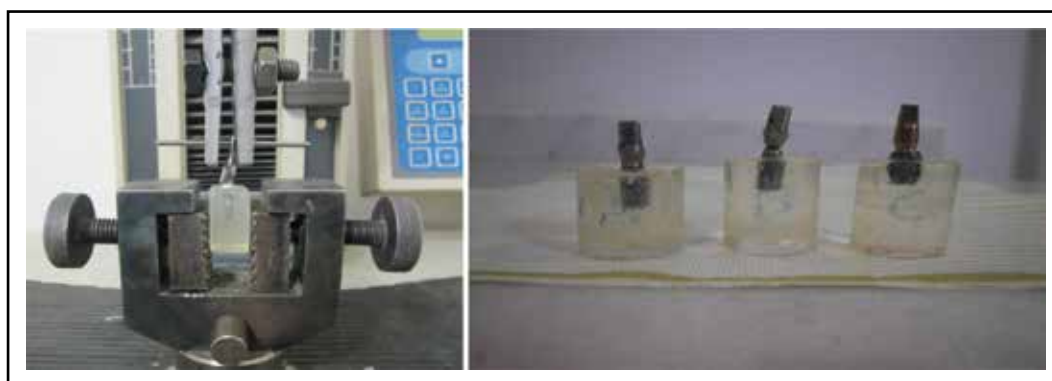
One way ANOVA followed by pair-wise Newman-Keuls post-hoc tests were performed to detect significance between subgroups. Pair-wise student t-test was performed to detect interaction between variables of significant effect.

Statistical Analysis related to TOC Retentive Forces as function of cement:

It was found that for **Group A (6o)** the mean $\pm$ SD values were $(383.145 \pm 47.681 \text{ N})$ with Multilink N cement and $(289.978 \pm 47.086 \text{ N})$ with Rely X U 200 cement.

While for **Group B (8o)** the mean $\pm$ SD values were $(299.619 \pm 13.354 \text{ N})$ with Multilink N cement and $(333.517 \pm 8.660 \text{ N})$ with RelyX™ U200 cement.

Group C (12o) the mean $\pm$ SD values were $(297.111 \pm 50.124 \text{ N})$ with Multilink N cement and $(269.487 \pm 34.703 \text{ N})$ with Rely X U200 cement.



Analysis of variance (ANOVA) test of significance:

Table (1) two way analysis of variance ANOVA test of significance comparing variables affecting retentive force results

Source of Variation	Df	SS	MS	F	P value
Convergence groups	2	28955.65	14477.83	6.1376	0.003*
Cement	1	12584.3	12584.3	5.3349	0.024*
Interaction	2	40376.49	20188.25	8.5585	0.001*

Influence of total occlusal Convergence groups:

Regardless of the cement type, totally it was found that **Group A** recorded the highest retentive force mean values followed by **Group B** while **Group C** recorded the lowest retentive force mean values. The difference between all groups was statistically significant ($p < 0.05$). Pair-wise Newman-Keuls post-hoc tests showed that the difference between **Group A** and **Group B** was statistically non-significant ($p > 0.05$).

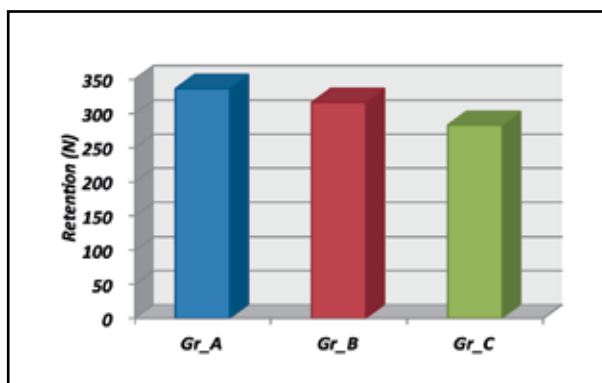


Fig. (1) A column chart comparing between total retentive force mean values as function of convergence groups

Influence of cement type:

Irrespective of convergence groups, totally it was found that **Multilink N** group recorded statistically significant ($p < 0.05$) higher retentive force mean values than **Rely X U200** one.

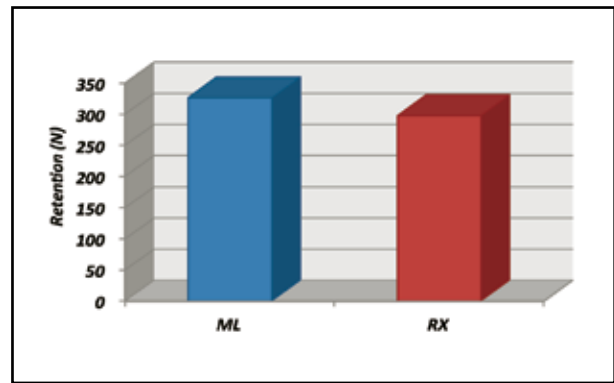


Fig. (2) A column chart comparing between total retentive force mean values as function of cement

DISCUSSION

The cemented implant supported crowns were used because of its advantages over the screw retained one. They have the advantages of simplicity, hermetic sealing of the abutment–crown interface, favorable aesthetics and crown contour, and a single interface between abutment and implant.^(8,9)

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. Retrievability is highly desirable for cleaning and it facilitates evaluation for mobility ailing implants.^(2, 9,10) However, the use of such cemented superstructure on an implant might not permit its removal for future maintenance.^(11,12)

The convergence of the abutments used in the cemented implant system has a great role in retention of the restoration. In this study a total occlusal convergence of 6°, 8° and 12° were used respectively. Abutments were fabricated using a CAD/CAM system. In comparison to cast abutments, there is no need for complicated and time-consuming titanium casting and post- casting manipulation that may produce inaccuracies; hence, the CAD/CAM abutment fit may be more precise. Moreover, the CAD/ CAM custom abutments have better physical properties since the material is processed from a homogenous mass under more controlled conditions, with no need for abutment inventory.⁽¹³⁾

In practice, ideal axial wall convergence is rarely obtained, and lack of retention is a common cause of fixed prosthesis failure. In this study, the use of a smooth surface and angled titanium abutment may have increase the mechanical retention of the cemented copings. The results would likely be different if the implants were not positioned perpendicular to the horizontal crestal plane and if the study was repeated with other implant systems.⁽¹⁾

In the current study, the copings were cemented on the same abutments multiple times. Reduced retention may occur if a coping is cemented over an abutment again if any cement remains on the abutment.⁽⁵⁾ Although care was taken to remove all cement from the abutment and the casting after tensile loading, it is possible that the fit of the castings were not similar.

In implant dentistry, careful consideration of the choice of the cement type include reference to abutment and crown specifications, opposing surfaces characteristics, desired retention, individual properties of preferred cement and ease of excess cement removal.^(14,15) The dental cements used for cement retained implant supported restorations may present different effects when compared with those used on teeth.⁽¹⁶⁾

In considering implant abutment- retained crowns. The ideal cement should be strong enough to retain the crown indefinitely, yet weak enough to allow the clinician to retrieve it if necessary.⁽¹⁷⁾

Type of luting agent and variations in its viscosity also affected the retentiveness of definitive restorations.^(1,18,20,21) 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.⁽²²⁾

The majority of cements used in implant dentistry at present have been designed for use with crowns lutes to natural teeth. 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. Different types of cements provide different levels of crown retention.^(22,23)

Logically, no single retrievable cement will suffice for all clinical situations. The type of cement used is also an important consideration because it affects the retention characteristics of the restoration. It may be desirable to use a type of cement that allows the restoration to be retrieved, so that superstructure can temporarily be cemented to evaluate the loading of implant occlusion, tissue response and screw loosening. Although the rationale for temporary cementation was based on the idea of providing ease in retrievability of the prosthesis, quick washout of such cements in the oral cavity possibly poses risk to periodontal health when the maintenance schedule cannot be kept properly.⁽²⁴⁾

In this study, permanent cements were used, Resin Modified Glass Ionomer cement (Rely X™ U200) and dual cure self-adhesive Resin Cement (Multilink N) were used with customized titanium implant abutments and metal casted copings.

Multi-link N self-adhesive resin cement was used in this study; it is a self-curing, self-etching luting composite system, which can be used for nearly all the typical clinical cementation applications. Moreover, it also offers the possibility of final light-curing. In the Multilink / Multilink Primer system, the material sets quickly and reliably and excess cement can be easily removed.

Together with the Multilink Primer, very high bonding values are achieved after only a short time. In investigations on the marginal quality, Multilink N also showed outstanding results. The silane methacrylate group establishes a bond to silicate ceramic materials, the phosphoric acid methacrylate group is responsible for bonding to zirconium oxide, aluminium oxide and base metals and the disulfide methacrylate group creates a bond to gold and precious metals and the corresponding alloys.

Also, it is radio-opaque cement with 350% opacity compared with aluminium.

Rely X™ U 200 is resin modified glass ionomer cement, this cement adheres to metal by chelating metallic ions, but the retentive strength may be weakened by early water contact. ⁽²⁵⁾

In this study higher bond strength was recorded for Group A (6°) with Multilink N Resin Cement, while the lowest bond strength was recorded for Group C (12°) with Rely X™ U200 Resin Modified Glass Ionomer Cement .

A combination of Resin cements and titanium alloy was reported to have higher bond strength compared to other alloys. ⁽¹²⁾

In this study the samples were stored in 37 °C incubator for 24 hours after cementation and then thermo cycled for 500 cycles (5-55) with 30 s dwell time. Long-term water storage and thermal cycling are the conditions most often used to test the durability of cements bonds. However long-term water storage was combined with thermal cycling at regular intervals to test the durability of the bonds.⁽¹⁸⁾ Some cement, particularly the glass ionomers, have been found to be especially sensitive to early moisture. ^(11,14)

In this study, base metal alloys were used for the cast restorations. Base metal alloys are less expensive than noble base alloys, so they are preferred for most cast restorations. Reduced retention may occur if a crown is cemented over an abutment again if any cement remains on the abutment.⁽⁵⁾ Although care was taken to remove all cement from the abutment and the casting after tensile loading, it is possible that the fit of the castings was not as good as with the first group.

Uniaxial tensile testing was employed in the current study as it permitted comparison with previous investigations of a similar nature. ⁽²⁷⁾ A purely tensile test may not represent the clinical stresses where other non-axial forces may contribute to crown de-cementation. ⁽²⁸⁾

The range of retention values and standard deviations in the current study were high. This has been noted and discussed in other studies of this nature and may be related to difficulties in study design including small sample sizes, construction and testing variations and the relative unpredictability and sensitivity of cements.^(7,27,29)

CONCLUSIONS

Within limitations of this In Vitro study:

1. Both Total occlusal convergence and Cement type have significant effect on retention of cement retained implant supported restorations.
2. Increase of Total occlusal convergence of implant abutments decreased the retention of the cemented crowns.
3. Resin Cement (Multilink N®) enhanced the retention of the cemented crowns compared with Resin Modified Glass Ionomer Cement (Rely X™ U200).

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