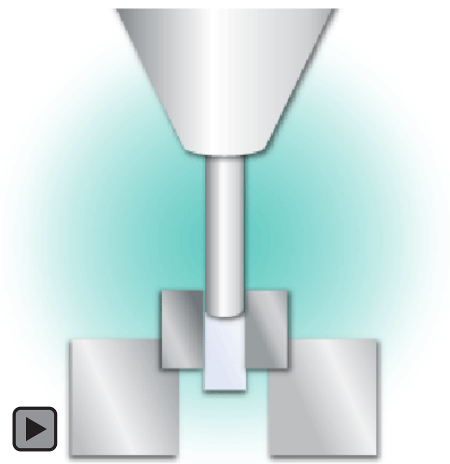
the Journal of CONTEMPORARY DENTAL PRACTICE
at www.thejcdp.com
Volume 10 Number 3 May 1, 2009

A Comparison of Two Methods of Removing Zinc Oxide-eugenol Provisional Cement Residue from the Internal Surfaces of Cast Restorations

Ramin Mosharraf, DDS, MS; Bahram Soleimani, PhD;
Mehdi Sanaee-Nasab, DDS



Abstract

Aim: Remnants of provisional cement on the internal surface of cast restorations can have an adverse effect on the performance of the definitive luting agent. The purpose of this study was to evaluate the effect of eugenol-containing temporary cement removal by an ultrasonic or an organic solvent on the retentive strength of metallic rings cemented to amalgam cores using zinc phosphate cement.

Methods and Materials: A total of 36 cylindrical amalgam cores measuring 5.9×6 mm were made by condensing amalgam in brass molds for use in this *in vitro* study. Thirty-six cylindrical spaces measuring 6×6 mm were machined in the center of cast rods of Rexillium III alloy to create simulated retainers. The amalgam cores were divided into two groups and provisionally cemented in these cylindrical spaces (retainers) using zinc oxide–eugenol cement. After separation of the cores from the retainers, one group was cleaned with an ultrasonic cleaning device with water and the other group was cleaned with Solitine organic solvent. All specimens were then cemented with zinc phosphate cement and the samples were stored at 100% humidity in a 37°C water bath after which they were tested with a DARTEK testing machine at a 0.02 cm/minute cross head speed. The data were analyzed using the Independent t-test.

Results: The statistical analysis revealed a significant difference between the two groups ($p<0.0005$) with the ultrasonic group having significantly higher separation forces than the Solitine group.

Conclusion: Specimens treated with the ultrasonic cleaner showed a higher mean separation force (282.2 MPa) than the solvent group (439.5 MPa).

Clinical Significance: Despite the convenience of using an organic solvent for cleaning the internal surface of cast restorations, the ultrasonic cleaning method is more effective for removing zinc-oxide temporary cement.

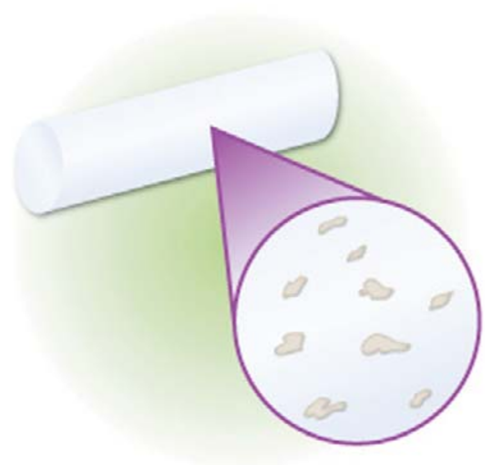
Keywords: Zinc oxide-eugenol, provisional cement, cast restorations

Citation: Mosharraf R, Soleimani B, Sanaee-Nasab M. A Comparison of Two Methods of Removing Zinc Oxide-eugenol Provisional Cement Residue from the Internal Surfaces of Cast Restorations. J Contemp Dent Pract 2009 May; (10)3:027-034.

Introduction

Cast restorations can be provisionally cemented to allow the patient and dentist to assess esthetics and function over a period of time.[1,2] Zinc oxide–eugenol (ZOE) cements are commonly used for provisional cementation[3,4] because of their sedative effect on sensitive teeth, low cost, ease of removal, and excellent seal to prevent leakage.[5,6] Residual provisional cement and debris on internal surface of cast restorations can have a negative effect on the performance of the definitive cement.[7-9] Therefore, it is necessary to remove the remnants of the provisional luting agent and other debris before final cementation.[1,10,11] Mechanical removal of temporary cements (such as removal with an excavator[6] or scalpel blade[12]) was found to be somewhat ineffective as remnants of the cements were observed microscopically on casting surfaces that appeared to be clean macroscopically.[13,14] Therefore, different attempts have been made to eliminate the remaining provisional cement.[6] Airborne-particle abrasion, ultrasonic cleaning, steam cleaning, and the use of organic solvents such as alcohol, soap, chloroform, eucalyptus oil, or a wax-pattern cleanser (Solitine, Kerr, Orange, CA, USA) are common methods of cleaning the internal surface of cast restorations.[1-3,7,15] Airborne-particle abrasion and ultrasonic methods may be more effective,[1,7,16,17] but the use of organic solvents to clean restorations is simpler.[2]

The purpose of this study was to evaluate the effect of eugenol-containing temporary cement removal by ultrasonic or an organic solvent (Solitine) on the retentive strength of metallic rings (simulated retainers) cemented to amalgam cores using zinc phosphate cement.



Methods and Materials

The method used in this study was the same as used by Millstein et.al.[18,19] In this *in vitro* study 36 cylindrical amalgam cores measuring 5.9×6 mm were made by mixing Cinalux high copper amalgam (Cinalux, Sh. Dr. Faghihi Dental Co., Tehran, Iran) according to the manufacturer's instructions then condensing the amalgam into brass molds. The hardened cores were then separated from the molds and stored at 100% humidity in a 37°C water bath (Whip Mix Corporation, Louisville, KY, USA). Sharp edges and corners were removed from all cores using a laboratory handpiece and an abrasive cutting instrument. The cores were then cleaned with distilled water in an ultrasonic bath (Biosonic® Ultrasonic Cleaner UC300, Coltene Whaledent, Langenau, Germany).

Thirty-six cast rods of Rexillium III alloy (Jeneric Industries, Inc., Wallingford, CT, USA) with 9 mm diameter and 6 mm length were chosen and

36 cylindrical spaces measuring 6×6 mm were machined into the center of the ends of the rods to create simulated metallic retainers for testing the retentive strength when cemented to the amalgam cores.

A spark erosion machine (EDM 511, Pishraneh, Sari, Iran) was used to create the initial 5.5 mm diameter holes in the Rexillium III alloy rods because this alloy is very difficult to machine. Turnery drills (Percision Turnery, Demonte Fratelli, Turin, Italy) with sizes ranging from 5.6, 5.7, 5.8, 5.9, and 6 mm diameters were used to adjust the hole size to ensure the amalgam cores could be placed in each retainer, leaving a uniform cement space of 0.05 mm, as well as to smooth the rough internal surfaces of the holes. Next the inner surfaces of the retainer holes were then sandblasted (Type 5417, KaVo Dental GmbH, Warthausen, Germany) with a fine-grain aluminum oxide abrasive (Aluminum Oxide 50µm, Item No.1906, Ronvig Dental Mfg., Daugaard, Denmark) to assure adequate surface contact during cementation. Retainers were then cleaned with a detergent (Golrang, Tehran, Iran) in an ultrasonic bath and washed in acetone.

Cores were provisionally cemented in the metallic retainers using ZOE provisional cement (Temp Bond, Kerr Italy, Salerno, Italy). Mixing included dispensing equal amounts of base and accelerator pastes and mixing them according to manufacturer's instructions. The mixed cement was applied to the internal surfaces of the metallic retainers and external surfaces of the cores with a plastic instrument. Cores were seated in the retainers using finger pressure while they were pressed against a flat glass mixing slab. Complete seating was assured because of the double open-ended design of the retainers. Mixing and insertion times did not exceed 60 seconds per retainer.

After 30 minutes, excess cement was removed and all the samples were stored in 37°C water bath for 24 hours. The cores were pushed out from their retainers which were placed on a steel base using a hammer and a 5.8 mm diameter shaft.

The amalgam cores were cleaned for 10 seconds with 50 µm aluminum oxide airborne-particle abrasion (Aluminum Oxide 50µm, Item No.1906, Ronvig Dental Mfg., Daugaard, Denmark) to remove temporary cement or other debris.[20] Before cleaning the retainers, they were randomly divided equally into two groups. One group of retainers was cleaned with an ultrasonic cleaning device with water (Biosonic® Ultrasonic Cleaner UC300, Coltene Whaldent, Langenau, Germany) for one minute and the other group was cleaned with Solitine-saturated cotton pellets followed by alcohol-saturated cotton pellets to remove the Solitine residue.[2]

When all the specimens were macroscopically clean, they were cemented with zinc phosphate cement (Richter & Hoffmann, Harvard Dental GmbH, Berlin, Germany) in the same manner used for the provisional cementation. The zinc phosphate cement was mixed and handled according to manufacturer's instructions. The samples were stored at 100% humidity in a 37°C water bath until tested.

Each core-retainer assembly was seated in a specially machined base (Figure 1) which was placed in a universal testing machine (TLCLO, Dartec series, London, UK). Retainers were placed in a machined metal base to make room for core extrusion. The cores were then forced out of the retainers with a hardened steel compression rod at a cross head speed of 0.02 cm/min. Peak separation loads were

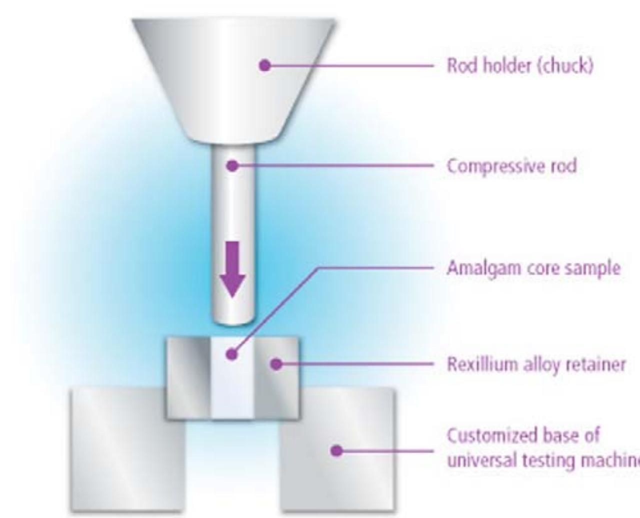


Figure 1. Core-retainer assemblies were seated in a machined base in a universal testing machine.

Table 1. Means and standard deviations of separation forces (MPa).

Group	N	Maximum	Minimum	Mean	Std. Deviation
Solitine	18	615	149	282.2	101.7
Ultrasonic	18	272	305	439.5	108.2

recorded. The data were analyzed using the Independent t-test statistical analysis at the 95% confidence level with computer software (SPSS, version 11.5, SPSS Inc., Chicago, IL, USA).

Results

Table 1 shows the mean separation forces between the two cleaning methods. The Independent t-test statistical analysis revealed statistically significant differences ($p<0.0005$) between the two groups.

Discussion

It is common practice during the fabrication of cast restorations to temporarily cement the restorations with a ZOE-based provisional cement. Later, the restorations are carefully cleaned and luted with zinc phosphate or another type of definitive cement.[9] Because of its consistency, ZOE remnants might remain on the internal surfaces of cast restorations after removal and cleansing of the provisionally cemented restorations.[11,12] The ultrasonic and organic solvent methods are among the most common methods of cleaning the internal surfaces of cast restorations and were selected for this study because of their simplicity of use and availability.[2]

An amalgam alloy was selected as the adherend because it is common for a major part of the surface that supports and retains a casting restoration to be an amalgam restoration. Composite cores were not selected because eugenol-containing luting cements can adversely affect their surface properties.[21] Furthermore, human dentin is an unreliable adherend for an *in vitro* investigation because of its complex and variable structure.[21]

Zinc phosphate cement is a time-honored, standard luting agent selected for the final cementation in this study because of its widespread use for cementing cast restorations.[1] However, there is some controversy in the literature regarding the interaction between this cement and ZOE cement residues.[4,9,11-12,18-19]

Solitine is an organic solvent composed of isoparaffinic hydrocarbon oil, lanolin, and fragrance[22] chosen for the present study because of the lack of research on its application as a cleaning agent for cast restorations.

The samples were not thermocycled because the aim of this study was to compare two cleaning methods; therefore, the results reflect the maximum bond strength between amalgam and cement rather than the strength of joints disturbed by changes in temperature.

In the present study specimens treated with the ultrasonic cleaner using water as a media showed a higher mean separation force (439.5 MPa) than the Solitine solvent group which had a significantly lower (282.2 MPa) mean separation force ($p<0.0005$). This finding is in accordance with some studies suggesting airborne-particle abrasion and the ultrasonic method may be more effective than other cleaning methods.[1,2,7,12] The destructive effects of the ZOE residues on resin luting cements have been reported previously, and use of temporary cements containing eugenol are not recommended prior to luting with resin based cements. However, some investigators believe ZOE residues on the tooth surface do not modify the retentive strength of zinc phosphate cement.[4,9,11-12,18-19]

Despite this previous finding the present study demonstrated the cleansing of internal surfaces of castrestorations with Solitine solvent before definitive luting with zinc phosphate cement is not as effective as the ultrasonic cleaning method. This might be attributed to ZOE cement consistency that makes its cleaning difficult.[12] Moreover, residual ZOE on the internal surfaces

of cast restorations are almost always present even though these surfaces might appear free of debris because remnants of ZOE-based cements were observed microscopically on the surfaces appearing to be macroscopically clean.[13,14] This may be due to the effectiveness of the ultrasonic method in cleansing fine irregularities in the internal surfaces of castings in comparison with the Solitine solvent. ZOE residue appeared to accumulate in the fine irregularities in the Solitine group in the present study. Some authors believe the residues alter the luting properties of definitive cements.[11]

The findings of the present study do not coincide with Abo-Hamar et al.[6] who reported the use of temporary cements does not alter the retentive strength of definitively luted ceramic restorations regardless of whether they contain eugenol or whether these temporary cements are removed using an excavator or by sandblasting.

Conclusion

Within the limitations of this *in vitro* study, specimens treated with the ultrasonic cleaner and water demonstrated a higher mean separation force (282.2 MPa) than the solvent group (439.5 MPa).

Clinical Significance

Despite the convenience of using an organic solvent for cleaning the internal surface of cast restorations, the ultrasonic cleaning method is more effective for removing zinc-oxide temporary cement.

References

1. Rosenstiel SF, Land MF, Fujimoto J. Contemporary fixed prosthodontics. 3rd ed. St. Louis: Mosby; 2001. p. 765, 771.
2. Mosharraf R. A simple method for cleaning zinc oxide–eugenol provisional cement residues from the internal surface of casting restorations. J Prosthet Dent 2004; 91:200.
3. Shillingburg HT, Hobo S, Whitsett LD, Jacobi R, Brackett SE. Fundamentals of fixed prosthodontics. 3rd ed. Carol Stream: Quintessence; 1997. p. 406.
4. Leirskar J, Nordbø H. The effect of zinc oxide-eugenol on the shear bond strength of a commonly used bonding system. Endod Dent Traumatol 2000; 16:265-8.
5. Carvalho CN, de Oliveira Bauer JR, Loguercio AD, Reis A. Effect of ZOE temporary restoration on Resin-Dentin Bond Strength Using Different Adhesive Strategies. J Esthet Restor Dent 2007; 19:144–53.
6. Abo-Hamar SE, Federlin M, Hiller KA, Friedl KH, Schmalz G. Effect of temporary cements on the bond strength of ceramic luted to dentin. Dent Mater 2005; 21:794-803.
7. Ayad MF, Rosenstiel SF, Hassam MM. Surface roughness of dentin after tooth preparation with different rotary instrumentation. J Prosthet Dent 1996; 75:122-8.
8. Grasso CA, Caluori DM, Goldstein GR, Hittelman E. *In vivo* evaluation of three cleansing techniques for prepared abutment teeth. J Prosthet Dent 2002; 88:437-41.
9. Worley JL, Hamm RC, von Franhofer A. Effects of cement on crown retention. J Prosthet Dent 1982; 48:289-91.
10. Sarac D, Sarac YS, Kulunk S, Kulunk T. Effect of the dentin cleansing techniques on dentin wetting and on the bond strength of a resin luting agent. J Prosthet Dent 2005; 94:363-9.
11. Dilts WE, Miller RC, Miranda FJ, Duncanson MG. Effect of zinc oxide-eugenol on shear bond strengths of selected core/cement combinations. J Prosthet Dent 1986; 55:206-8.
12. Mojon P, Hawbolt EB, MacEntee MI. A comparison of two methods for removing zinc oxide-eugenol provisional cement. Int J Prosthodont 1992; 5:78-84.
13. Watanabe EK, Yamashita A, Imai M, Yatani H, Suzuki K. Temporary cement remnants as an adhesion inhibiting factor in the interface between resin cements and bovine dentin. Int J Prosthodont 1997; 10:440–52.
14. Terata R. Characterization of enamel and dentin surfaces after removal of temporary cement—study on removal of temporary cement. Dent Mater 1993; 12:18–28.
15. Dersley G, Masri R. A technique to recement provisional crowns by reactivating residual zinc oxide–eugenol cement. J Prosthet Dent 2006; 95:397-8.
16. Peutzfeldt A, Asmussen E. Influence of eugenol-containing temporary cement on efficacy of dentin bonding systems. Eur J Oral Sci 1999; 107:65-9.
17. O'Connor RP, Nayyar A, Kovarik RE. Effect of internal micro blasting on retention of cemented cast crowns. J Prosthet Dent 1990; 64:557-62.
18. Millstein PL, Hazan E, Nathanson D. Effect of aging on temporary cement retention *in vitro*. J Prosthet Dent 1991; 65:768-71.
19. Millstein PL, Nathanson D. Effects of temporary cementation on permanent cement retention to composite resin cores. J Prosthet Dent 1992; 67:856-9.
20. Fonseca RB, Martins LR, Quagliatto PS, Soares CJ. Influence of provisional cements on ultimate bond strength of indirect composite restorations to dentin. J Adhes Dent 2005; 7:225-30.
21. Gregory WA, Campbell Z. Interim luting agents, composite core surface hardness and retention of interim and final restorations. Am J Dent 1990; 3:207-12.
22. http://www.google.com/search?q=cache:xexMwPuGlwYJ:www.kerrdental.com/msds/kerrlab/us/english/Solitine.pdf+solitine&hl=en&ct=clnk&cd=4

About the Authors

Ramin Mosharraf, DDS, MS

Dr. Mosharraf is an Associate Professor and the Head of the Department of Prosthodontics in the School of Dentistry at Isfahan University of Medical Sciences in Isfahan, Iran. His research interest is focused on prosthetic dental materials. He is a member of the International Association of Dental Research (IADR), the Iranian Academy of Prosthodontics, and the Torabinejad Dental Research Center.

e-mail: mosharraf@dnt.mui.ac.ir

Bahram Soleimani, PhD

Dr. Soleimani is an Associate Professor in the Department of Public Health of the School of Medicine at the Islamic Azad University in Najafabad, Iran.

Mehdi Sanaee-Nasab, DDS

Dr. Sanaee-Nasab received his dental degree from the Khorsgan Azad University in Isfahan, Iran.