Cement selection of cemented implant supported restorations

Siman tutuculu implant destekli restorasyonlarda siman seçimi

Altay Uludamar, DDS, MSc, PhD,[a] Yasemin Kulak Ozkan,DDS, PhD[b]

[a]Private Practice, Ankara, Turkey
[b]University of Marmara, Faculty of Dentistry, Department of Prosthodontics, Istanbul, Turkey.

Received: 02 March 2011 Accepted: 14 May 2011

ABSTRACT
Implanted-supported restorations are an accepted, clinically successful treatment modality to replace missing teeth. The clinicians have a choice between screw-supported and cement-supported implant restorations (CSIR). Cement supported implant restorations are routinely used implant retained restorations. When treatment planning cement-supported implant restorations, the clinical success and durability of these definitive restorations include many factors, including the choice and clinical technique for definitive cement for final restorations. Currently, within the variety of cement available, clinicians have a number of choices for cement-retained implants. In considering CSIR the ideal cement should be strong enough to retain to crown indefinitely, yet weak enough to allow the clinician to retrieve it if necessary. These articles provide an overview about cement used CSIR.
Keywords: Implant restorations, cement retention.

In recent years there has been remarkable progress in the field of implant dentistry. However, many questions have arisen regarding the materials used and techniques followed in clinical practice. One of the questions is related to the method by which fixed partial dentures (FPD) are connected to underlying implants: screw retained or cemented?

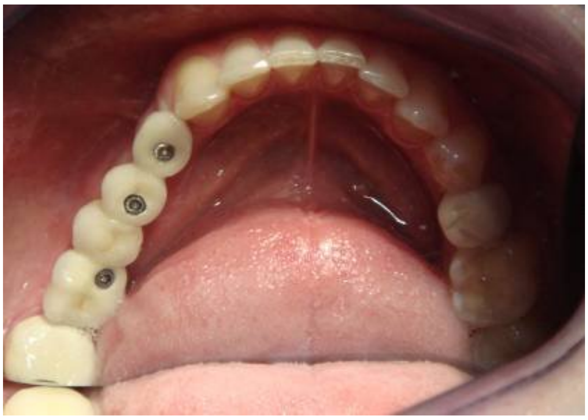
The choice of cementation versus screw retention prosthesis

The use of screw retained versus cement-retained implant restorations has been subject of controversy in the literature (1-3). Prostheses utilizing screw retention have been and remain the standard design in most situations for many clinicians. Other prefers to fabricate more traditional dental restorations for implant use, involving cement restoration. For screw-retained restorations, retention is obtained by the fastening screw, which connects the implant with the abutment and the abutment with the prosthesis.[1]

The primary objective of this tightening is to generate adequate clamping force to maintain unity of the components.[4] Currently, there are numerous abutment screws with different mechanical properties. Some authors advocate screw-retained restorations, as established by Adell and co-vorkers, due to reversibility and security at the implant-abutment prosthetic interface.[1,4,5] Screw retained restorations presents in the situation where there is limited interarch space and therefore a limit to the desired height of axial walls for retention of a cement-retained prosthesis[1] (Figures 1A and B).

However, screw-retained implant supported prostheses may require additional maintenance because screws may loosen or break. In addition, the aesthetics of screw-retained prostheses

Altay ULUDAMAR
Filistin cad. Kader sok. No: 6
Kat: 1, D: 1
Gaziosmanpaşa/ Ankara/ Turkey
e-mail: a.uludamar@superonline.com



A

B

Figure 1A and B. Screw retained restorations used limited interarch.

A

B

Figure 2A and B. Cement retained restorations used anterior region.

may be compromised if the access opening is positioned near the facial surface. The problem of retaining screw stability has been addressed by the use of gold alloy screws and torque controlling devices.[4,6] This allowed the development of cemented implant-supported restorations (CISR).[7] CISR have the advantages of simplicity, hermetic sealing of the abutment–crown interface, favourable aesthetics and crown contour, and a single interface between abutment and implant[3,4] (Figures 2A and B).

The cement space existing between the crown and abutment can help to compensate for discrepancies in the fit of crown.[4,7] The fabrication of CISR easier than that for screw retained prostheses, because traditional prosthetic techniques are followed and there is no need for special training of the laboratory technicians. The components use for this type of restorations is less expensive than those of the screw type. Restorations of implants with a divergence of less than 17 degree are also easier with cement retained restorations.[3] 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.[4,6,8] However, the use of such cemented superstructure on an implant might not permit its removal for future maintenance.[9-11] But the selection of method of the crown retention presents clinician with a treatment challenge that involves recognition of the drivers of the desired treatment option.[12] There are concepts that influence the increased retention of a cemented prosthesis: parallelism between the abutments, surface area and height, surface roughness and the type of cement.[7,13-16]

Type of Cement

Regarding this aspect, the type of cement is a relevant and decisive factor for retention. Careful consideration of the choice of cement include reference to abutment and crown specifications, opposing surface characteristic, desired retention, individual properties of preferred cement and ease of excess cement removal.[17-20] The dental cements used for CISR may present different effects when compared with those used on teeth.[21] 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.[22] Also, the option to cementing crowns to implant abutments may be elected, or contrastingly forced upon the clinician due to implant position and implant number. Previous studies in the area of CISR focus on the use temporary cements such as TempBond to permanently cement crowns in order to improve the chance of retrieval if needed[7,13-15,17,21,23-42] although variations exist in the quantity of retention provided by same type of cements used either with different implant systems and under different in vitro conditions.[16,17,22,26,29] However, there are few studies comparing one unit and multiple unit restorations with both provisional and permanent cements subjected to various in vitro simulations and the literature yet again appears to be lacking for information on these different systems and the behaviour of luting cements subjected to in vitro simulations.[14,15,25,28,30] There are many factors that can influence the amount of retention that can be achieved when luting a restoration. 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.[11-15] The material differences, the design differences, and the fabrication differences of the implant prostheses must be considered for the selection of cements. Results would be different if implants were not positioned perpendicular to the horizontal crestal plane and if the study was repeated with other implant systems.[43]

Studies about cement selection

Mansour et al.[28] examined the retention of 6 cements for two different CISR on ITI solid titanium abutments the unaltered smooth machined abutment surface was used. This method could have decreased the cement-abutment micromechanical interlocking, leading to comparatively decreased cement retention values but a rougher surface may have resulted in greater retention values and possibly different modalities of cement failure. Surface roughness increases the retention due to resulting micro retentive ridge and groove patterns. As reported, surface roughness enhanced crown retention as much as 31% other factors being equal.[35] In most comparative studies, which generally used the abutments were at most 5 mm in height, had smooth surfaces and the retentive values that ranged from 67N to 139 N.[24,37] Abbo et al.[40] investigated resistance to dislodgement of zirconia copings cemented onto titanium abutments of different heights with provisional cement. They found that the mean tensile bond strength values or the force required dislodging the coping from the abutment after cementation with provisional cement for the standard and shorter abutments were 189.01N and 124.9 N, respectively. Covey et al.[7] investigated effects of abutment size and luting cement type on the uniaxial retention force of implant-supported crowns. They found that permanent cement (307 N) led to significantly greater retention than use of a provisional luting agent (100 N).

Cement selection criteria

Selection of a cement that is too retentive could lead to damage due use of aggressive removal techniques. On the other hand, the selection of cement that is not retentive enough could be a potential source of embracement for the patient.

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.[29] The retrievability issue and the possible need for re-cementation of loosened crowns demonstrate the difference between new, clean surface versus re-cementation of previously cemented components. The effect of repeated use of components on retentive values of cements is unknown, but there is a possibility that changes occur on the inner surface of the metal castings or on the abutment surface.[37,44] Cast restorations can be difficult to remove from prepared teeth after cementation with provisional luting agents; this indicates that a luting agent with a low retentive strength should be used when the necessity to retrieve the castings is anticipated. Also CISR, the effect of lateral forces during removal of a cemented superstructure should be considered, because these forces may be more harmful to the implant/tissue interface than vertical forces, especially if making multi unit restorations, these lateral forces may be more harmful.

The effect of metal type

The ability of cement to bond to a restorative alloy is critical for maximal crown retention. Metal type may have an important role in optimizing cement-to-metal strength. Base metal alloys cheaper than noble base alloys so they preferable to choice for most of casting restorations. Abreu et al.[45] investigated the effect of surface pretreatment on the tensile strength of base and noble metals bonded using conventional resin cement. They stated that metal type did not significantly affect tensile bond strength for any of the compared surface pretreatments. Hibino[46] investigated the influence of the type and oxidation treatment of dental casting alloys on the tensile bond strength of luting cements. He investigated four different luting cements (zinc phosphate, polycarboxylate, glass ionomer and adhesive resin cements) and four different dental casting alloys (Au-Ag-Cu, Ag-Pd, hardened Ag-Pd and Ni-Cr alloys). He stated that Ni-Cr alloy had the highest bond strength of any luting cement, compared to other alloys. Amina et al.[47] also stated that crowns made of base metal alloys provided superior retention with any adhesive resin luting system compared to those made of noble metal alloys for teeth with questionable retention. It could be that the outcome would be different if used for noble/semi-precious alloys in this study. Further study needed to evaluate for comparing base metal alloys and noble/semi-precious alloys.

Type of cement

Zinc-oxide noneugenol and resin-based provisional cements and resin, glass ionomer, zinc phosphate and zinc poly carboxylate permanent cements are some of the more readily available and widely used for traditional crown and bridge restorations, These types of cements are now employed clinically in cementing crowns to implant abutments.[11-14,17, 20-22, 27-29, 31,35,38-41,45]

Abbo et al.[40] investigated resistance to dislodgement of zirconia copings cemented onto titanium abutments of different heights with provisional cement. They found that the mean tensile bond strength values or the force required dislodging the coping from the abutment after cementation with provisional cement for the standard and shorter abutments were

189.01N and 124.9 N, respectively. Covey et al.[7] investigated effects of abutment size and luting cement type on the uniaxial retention force of implant-supported crowns. They found that permanent cement (307 N) led to significantly greater retention than use of a provisional luting agent (100 N). Clayton et al.[24] reported that zinc phosphate cement presented approximately six times higher strength than the zinc oxide-eugenol cement.

Michalakis et al.[41] measured the retentive strength of noneugenol containing luting cements on a fixed partial denture supported by 2 or 4 implants. The results showed the urethane resin provisional cement exhibited the highest mean retentive strength for both the 2- and 4-unit FPDs after thermal cycling and air abrasion treatments. Breeding et al.[17] also found that all 3 provisional cements were less retentive than the glass ionomer and 2 resin cements.

Zinc phosphate cement has lower retentive values for implant supported restorations compared to zinc polycarboxylate cement, glass ionomer cement and resin cement. Studies reported in the literature for uniaxial retention loads of implant, metal die, and natural tooth abutments ranging between 207-509 N.[11,24,37] This may be a result of the methodological differences between studies. When using a traditional non adhesive luting agent such as zinc phosphate, retention is dependent on the geometric form of the tooth preparation that limits the paths of displacement of the cast restoration. In practice, ideal axial wall convergence is rarely obtained, and lack of retention is a common cause of fixed prosthesis failure. Zinc phosphate cements provide casting retention by micromechanical interlocking into the casting and the abutment surface irregularities.[15] Therefore, the utilization of surface irregularities for retention of dental restorations depends on the compressive strength not only of the cement, but also of the adjacent tooth/metal material, this concept has important implications in cement-retained prostheses. Cements that provide casting retention mainly by mechanical interlocking (like zinc phosphate) will show, for similar roughness, a greater percentage increase in retention then adhesive cements.[15]

The retention provided by zinc polycarboxylate cement was significantly greater than zinc phosphate cements. This is likely explained by the adhesive properties of zinc polycarboxylate cement. It has been shown that, during setting of zinc polycarboxylate cement, it can adhere to metal substrates by chelation of metallic ions.[15] Retention obtained by zinc polycarboxylate cement could be due to adhesion of cements to the titanium abutments. Squier et al.[31] showed that resin cement had greater retention than glass ionomer cement and zinc phosphate cement. Breeding et al.[17] also found that all 3 provisional cements were less retentive than the glass ionomer and 2 resin cements.

Several influencing factors affect laboratory tests when evaluating the effectiveness of luting agents on the retention of crowns /bridges, and that these factors; including artificial aging should be considered when designing an experimental setup.[48] 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 bonding.[30] Some cement, particularly the glass ionomers, have been found to be especially sensitive to early moisture.[11,17] Chan et al.[9] reported that thermal cycling significantly decreased the retentive force of cementing abutments. GaRey at al.[30] reported that before thermal cycling cements showed greater retentive strength values.

It is unclear whether temporary cementation should be preferred over permanent cementation for CISR restorations. The use of appropriate cement for a specific restoration type may reduce cement failures. However, the clinical outcome of different cements used for different restorations has not been investigated.

The temporary and permanent cements showed a wide range of ability to retain for CISR. While it is difficult to predict clinical performance based solely on in vitro tests, the high degree of variability in the retentive strengths of these cements provides useful information about the selection of useful cement. Of interest they would also include the wide variety of coping surfaces, different type of coping surface, different type of structure (e.g. metal-ceramic, CAD-CAM ceramic and pressable ceramic), different type of metals (base metals and noble metals), different type of implants, and different type of implant prosthesis (three unit, four units etc) that would influence the mechanical retention of CISR

CONCLUSION

The cementation process in restorative dentistry, is a important factor in tooth enhancement or replacement procedures. Choosing a cement can depend on various issues; however, clinician preference usually plays a significant role in cement selection as well as the actual cementation clinical techniques followed. Great care must be taken to remove any excess cement material in peri-implant sulcular area, to ensure periodontal health to the gingival tissue surrounding the restoration itself. The authors recommend a thorough understanding of the cement material being used in order to properly use the cement to the best of its design characteristics

REFERENCES

1. Michalakis KX, Hirayama H, Garefis PD. Cement-retained versus screw-retained implant restorations: a critical review. Int J Oral Maxillofac Implants 2003;18:719-728.
2. Squier RS, Agar JR, Duncan JP, Taylor TD. Retentiveness of dental cements used with metallic implant components. Int J Oral Maxillofac Implants 2001;16:793-798.
3. Chee W, Felton DA, Johnson PF, Sullivan DY. Cemented versus screw-retained implant prostheses: Which is better? Int J Oral Maxillofac Implants 1999;14:137–141.
4. Vigolo P, Givani A, Majzoub Z, Cordioli G. Cemented versus screw-retained implant-supported single-tooth crowns: a 4-year prospective clinical study. Int J Oral Maxillofac Implants 2004;19:260-265.
5. Sakaguchi RL, Borgersen SE. Nonlinear contact analysis of preload in dental implant screws. Int J Oral Maxillofac Implants 1995;10:295-302.
6. Hebel KS, Gajjar RC. Cement-retained versus screw-retained implantrestorations: achieving optimal occlusion and esthetics in implant dentistry. J Prosthet Dent 1997;77:28–35.
7. Covey DA, Kent DK, St Germain HA, Koka S. Effect of abutment size and luting cement type on the uniaxial retention force of implant supported crowns. J Prosthet Dent 2000;83:344–348. [CrossRef]
8. Scheller H, Urgell JP, Kultje C, Klineberg I, Goldberg PV, Stevenson-Moore P, Alonso JM, Schaller M, Corria RM, Engquist B, Toreskog S, Kastenbaum F, Smith CR. A 5-year multicenter study on implant-supported singlecrown restorations. Int J Oral Maxillofac Implants 1998;13:212-218.
9. Chan DCN, Wilson AH, Barbe P, Cronin RJ , Chung C, Chung K. Effect of preparation convergence on retention and seating discrepancy of complete veneer crowns. J Oral Rehabil 2005;32:58–64. [CrossRef]
10. Randi AP, Hsu A Verga A, Kim JJ. Dimensional accuracy and retentive strength of a retrievable cement-

retained implant supported prosthesis. Int J Oral Maxillofac Implants 2001;16:547–556.

11. Sheets JL,Wilcox C, Wilwerding TJ. Cement selection for cement-retained crown technique with dental implants. J Prosthodont 2008;17:92-96. [CrossRef]

12. Dudley JE, Richards LC, Abbott JR. Retention of cast crown copings cemented to implant abutments. Aust Dent J 2008;53:332–339. [CrossRef]

13. Imbery TA, Burgess JO, Naylor WP. Tensile strength of three cements following two alloy surface treatments. Int J Prosthodont 1992;5:59-67.

14. Kent DK, Koka S, Froeschle ML. Retention of cemented implant-supported restorations. J Prosthodont 1997;6:193–196. [CrossRef]

15. Oilo G, Jorgensen KD. The influence of surface roughness on the retentive ability of two dental luting cements. J Oral Rehabil 1978;5:377-389. [CrossRef]

16. Uludamar A, Leung T. Inaccurate fit of implant superstructures. Part II: Efficacy of the Preci-Disc system for the correction of errors. Int J Prosthodont 1996;9:16–20.

17. Breeding LC, Dixon DL, Bogacki MT, Tietge JD. Use of luting agents with an implant system: part I. J Prosthet Dent 1992;68:737-741. [CrossRef]

18. Singer A, Serfaty V. Cement-retained implant-supported fixed partial dentures:a 6-month to 3-year follow-up. Int J Oral Maxillofac Implants 1996;11:645-649.

19. Felton DA, Kanoy BE, White JT. Recementation of dental castings with zinc phosphate cement: effect on cement bond strength. J Prosthet Dent1987;58:579-583. [CrossRef]

20. Gorodovsky S, Zidan O. Retentive strength, disintegration, and marginal quality of luting cements. J Prosthet Dent 1992;68:269-274. [CrossRef]

21. Kerby RE, McGlumphy EA, Holloway JA. Some physical properties of implant abutment luting cements. Int J Prosthodont 1992;5:321-325.

22. Ramp MH, Dixon DL, Ramp LC, Breeding LC, Barber LL. Tensile bond strengths of provisional luting agents used with an implant system. J Prosthet Dent 1999;81:510-514.

23. Alfaro MA, Papazoglou E, McGlumphy EA,Holloway JE. Short-term retention properties of cements for retrievable implant-supported prostheses. Eur J Prosthodont Restor Dent 2004;12:33-37.

24. Clayton GH, Driscoll CF, Hondrum SO. The effect of cements on the retention of the CeraOne implant system. Int J Oral Maxillofac Implants 1997;12:660-665.

25. Bresciano M, Schierano G, Manzella C, Screti A, Bignardi C, Preti G. Retention of cements on implant abutments of different height and taper. Clin Oral Implants Res 2005;16:594-598.

26. Carter GM, Hunter KM, Herbison P. Factors influencing the retention of cemented implant supported crowns. NZ Dent J 1997;93:36-38.

27. Akashia AE, Franciscone CE, Tokutsune E, da Silva W Jr. Effects of different types of temporary cements on the tensile strength and marginal adaptation of crowns on implants. J Adhes Dent 2002;4:309-315.

28. Mansour A, Ercoli C, Graser G, Tallents R, Moss M. Comparative evaluation of casting retention using the ITI solid abutment with six cements. J Clin Oral Implants Res. 2002;13:343-348. [CrossRef]

29. Akca K, Iplikcioglu H, Cehreli MC. Comparison of uniaxial resistance forces of cements used with implant-supported crowns. Int J Oral

Maxillofac Implants 2002;17:536-542.
30. GaRey DJ, Tjan AHL, James RA, Caputo AA. Effects of thermal cycling, load cycling, and blood contamination on cemented implant abutments. J Prosthet Dent 1994;71:124-132.
31. Squier RS, Agar JR, Duncan JP, Taylor TD. Retentiveness of dental cements used with metallic implant components. Int J Oral Maxillofac Implants 2001;16:793-798.
32. Diaz-Arnold AM, Vargas MA, Haselton DR. Current status of cements for fixed prosthodontics. J Prosthet Dent 1999;81:135-141.
33. Koyano E, Iwaku M, Fusayama T. Pressuring techniques and cement thickness for cast restorations. J Prosthet Dent 1978;40:544-548.
34. Silva EG, Moraes JV, Araújo MAM, Ushiwata O. A comparative *in vitro* study of the effect of thermocycling on the tensile bond strength of metal copings cemented over human teeth using two different luting agents. Rev Odontol UNESP 1998;27:537-551.
35. Kim Y, Yamashita J, Shotwell JL, Chong KH, Wang HL. The comparison of provisional luting agents and abutment surface roughness on the retention of provisional implant-supported crowns. J Prosthet Dent 2006;95:450-455. [CrossRef]
36. Onghiemsak C, Mekeyarajjananonth T, Winkler S, Boberick KG. The effect of compressive cyclic loading on retention of a temporary cement used with implants. J Oral Implantol 2005;31:115-120.
37. Ayad MF, Rosenstiel SF, Woelfel JB. The effect of recementation on crown retention. Int J Prosthodont 1998;11:177-182.
38. Olin PS, Rudney JD, Hill EM. Retentive strength of six temporary dental cements. Quint Int 1990;21:197-200.
39. Lawson NC, Burgess JO, Mercante D. Crown retention and flexural strength of eight provisional cements. J Prosthet Dent 2007;98:455-460
40. Abbo B, Razzoog ME, Vivas J, Sierraalta M. Resistance to dislodgement of zirconia copings cemented onto titanium abutments of different heights. J Prosthet Dent 2008;99:25-29. [CrossRef]
41. Michalakis KX, Pissiotis AL, Hirayama H.Cement failure loads of 4 provisional luting agents used for the cementation of implant-supported fixed partial dentures. Int J Oral Maxillofac Implants 2000;15:545-549.
42. Johnson GH, Lepe X, Bales DJ. Crown retention with use of a 5% glutaraldehyde sealer on prepared dentin. J Prosthet Dent 1998;79:671-676. [CrossRef]
43. Bernal G, Okamura M, Muñoz CA. The effects of abutment taper, length and cement type on resistance to dislodgement of cement-retained, implant-supported restorations. J Prosthodont 2003;12:111-115. [CrossRef]
44. Binon PP. Implants and components: Entering the new millennium. Int J Oral Maxillofac Implants 2000; 15:76–94.
45. Abreu A, Loza MA, Elias A, Mukhopadhyay S, Looney S, Rueggeberg FA. Tensile bond strength of an adhesive resin cement to different alloys having various surface treatments. J Prosthet Dent 2009;101:107-118. [CrossRef]
46. Hibino Y. Influence of types and surface treatment of dental alloy and film thickness of cements on bond strength of dental luting cements. Shika Zairyo Kika 1990;9:786-805.
47. Amina A. Zaki, Mohamed L. Zamzam, and Jylan F. El Guindy

retention of noble and base metal crowns: total-etch versus self–adhesive luting systems. Egypt Dent Assoc 2007;53:3019-3020.

48. Heintze SD, Crown pull-off test (crown retention test) to evaluate the bonding effectiveness of luting agents Dent Mater 2010;26:193-206. [CrossRef]