The Effect of Abutment Surface Roughness on the Retention of Implant-Supported Crowns Cemented with Provisional Luting Cement

Jalil Ganbarzadeh[1], Mohammad Reza Nakhaei[1], Farid Shiezadeh[2], Seyyed Mohammad Abrisham[1]

[1] Dental Research Center, Department of Prosthodontics, Faculty of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran
[2] General Dentist, Mashhad, Iran

Received 2 November 2011 and Accepted 5 March 2012

Abstract

Introduction: Surface roughness can increase the retention of castings by ridges and grooves that are microretentive. This study compared the retention of implant-supported crowns when used with 3 different surface roughness abutments and one temporary cement. **Methods:** Thirty solid abutments (ITI), 4 mm high, were divided into three groups randomly. In the first group, 10 abutments were roughened with sandblast (50-µm aluminum oxide) and in the second group, 10 abutments were roughened with diamond bur. The third group had no surface treatment. Then, thirty implant fixture analogs (ITI) were placed in the center of acrylic cylinders. After that a solid abutment was tightened on the each fixture analog with 35 N/cm force. Thirty base metal crowns were made on the 4 mm ITI abutment analogs using plastic coping. The prepared copings were cemented on the abutments by TempBond temporary cement and finally, crowns were pulled from the abutment in a universal test machine at a cross speed of 0.5cm/min. **Results:** The mean tensile strength in sandblasted, bur treated, and control group were 64.38±8, 91.37±7.19, and 58.61±1.93, respectively. Bur treated group showed higher tensile strength in comparison with two other groups. **Conclusion:** Surface modification of implant abutment by diamond bur may be an effective method to increase retention of crown when TempBond is used.

Key Words: Abutment, dental implant, restoration, retention, surface roughness.

Ganbarzadeh J, Nakhaei MR, Shiezadeh F, Abrisham SM. The Effect of Abutment Surface Roughness on the Retention of Implant-Supported Crowns Cemented with Provisional Luting Cement. J Dent Mater Tech 2012; 1(1): 6-10.

Introduction

Dental implants have shown high capability to restore esthetic and proper function of lost teeth. Also, they have a long durability and success. Long-term implant survival and success rates of dental implants have been demonstrated (1-3). Today, cement retained prosthesis, supported by implant, is more popular due to several advantages such as loading along linear axis, better passivity fit, small occlusal table (due to the lack of accessibility hole), lower fracture of porcelain due to lack of screw accessibility hole, and better comfort to cement restoration in posterior regions (4-6). The only considerable advantage of screw-retained prosthesis is its retrieval.

A common problem with implant-supported prostheses is abutment screw loosening or fracture. For this reason, prosthesis should have the capability of retrieval (7-13). This quality will appear when temporary cement is used in cement-retained prosthesis. Therefore, it is totally advisable to cement all implant-supported cement-retained prosthesis with temporary cement at delivery appointment to have the capability of retrieval. Anyway, when crown is luted with temporary cement, diminished retention can cause dislodgement of the crowns. So when temporary cement cannot create a suitable retention for a restoration, we need ways to increase retention.

Several factors such as abutment convergence angle, abutment height, surface roughness and type of luting cement can affect the retention of implant-supported crowns (14,15). Type of luting cement and surface texture of abutment such as roughness

are among the instances that can be changed by the clinician. In implant-supported restorations, different cements have shown different amount of retention (16-21). Surface roughness can also increase the retention of castings by ridges and grooves that are micro retentive (22-26). Therefore, the aim of this study was to evaluate the effect of abutment surface roughness on the retention of the crowns cemented with temporary cement.

Materials and Methods

Thirty ITI solid abutments (Strauman, Basel, Switzerland, Art No: 048.540), 4mm in height were selected and divided into 3 groups randomly. The first group was treated by sandblast (50-µm aluminum oxide) and the second group by an ISO 016 cylinder diamond bur (Tees kavan, Tehran, Iran); however, the last one had no treatment as control group. Thirty fixture analogues (Strauman, Art No: 048.124) were placed in the center of acrylic cylinder (Marlic CO, Tehran, Iran), 2mm above the margin. Afterward, abutments were closed on mounted analogues and were tightened with an ITI torque wrench with 35 N/cm (Strauman, Art No: 046.049). Thirty ITI abutment analogues (Strauman, Art No: 048.160) were selected and plastic copings (Strauman, Art No: 048.245) were placed on each abutment analogue. Then, shape and height of each coping were formed with blue inlay wax. Wax rings were added to the occlusal portion of the waxed copings. Specimens were invested and casted by base metal alloys (Verabond, Alba Dent, USA). The copings were seated on abutments and the insertion was tested with fit checker. Any marginal discrepancy or other visible problems caused the procedure to be repeated. Crowns and abutments were cleaned off pollution through boiling water and then were irrigated by normal saline. The copings were cemented on abutments using TempBond cement (Kerr, Salerno, Italy). Crown's margins were checked before cementation by a probe. Temporary cement were prepared according to manufacturer's instructions and placed in the crown. The copings were placed on corresponding abutments and were held in place with finger for 10 seconds. Then they were subjected to 6 Kg load for 10 minutes. Excessive cements were removed with the aid of an explorer after setting. Then samples were stored in distilled water at 37ºC for 24 hours. Each specimen was attached to universal testing machine (Instron 5565, Instron Corp, Cnton, Mass) with a 500Kg load cell and cross head speed of 0.5 cm/min. Crowns were pulled from the abutment and the ultimate tensile strength was recorded in Newton.

Collected data were analyzed by SPSS v 11. Results were analyzed using one-way analysis of variance (ANOVA) and Tukey's HSD tests.

Results

One-way ANOVA showed significant difference among the three groups (P<0.001) (Table 1). Tukey HSD test revealed the mean tensile strength of bur treated abutments was significantly higher than two other groups (P<0.0001) but there was no significant difference between sandblasted and control group (P=0.19) (Table 2).

Table 1. One-way ANOVA for tensile strength (N)

Source	Df	Sum of squared	Mean squares	F value	P value
Between Groups	2	6117.99	3058.99	59.11	.0001
Withen Groups	27	1397.05	51.74		
Total	29	7515.05			

Table 2. Mean tensile strength (N) for various surface roughness abutments

Abutments surface roughness	N	Mean ± SD	Tukey HSD test
a) Sandblasted	10	64.38±8	a:b P<0.001
b) Bur treated	10	91.37±7.19	a:c P=0.19
c) No surface treatment (control)	10	58.61±1.93	b:c P<0.001

Discussion

In this study, the effect of surface treatments of abutments on the retention was evaluated. This study demonstrated that roughening the surface of abutment by a bur increases the retention of cemented crowns in comparison with sandblast and control groups. Sandblasting the surface of abutment was not as effective as roughening it by bur.

One of the major concerns of cemented restorations is the challenge of retrieval when an abutment screw loosens. When selecting a luting agent, it is important for the cement to be easily manipulated and removed without any damage to implant components. For this reason a restoration is cemented with temporary cement at delivery appointment. On the other hand, the repeated dislodgement of restoration can always be a problem when implant-supported restorations are luted with a temporary cement. So in cases where temporary cement cannot maintain a proper retention for restoration, we need methods to increase retention. In fact, the retention of crown should be in a way to allow retrieval when necessary and at the same time it should have sufficient retention during function and should not dislodge off the abutment frequently (19). There are so many factors involved in retention of implant supported crowns such as angle of convergence in abutment, surface area of abutment, abutment height, surface roughness and type of luting cement used. A few factors can be controlled by clinicians in order to increase retention and surface roughness is one the most important factors that a clinician has control over it.

Inside the mouth, implant-supported restorations are under the influence of various forces such as shear, tensile and compressive and the combination of these forces can create different dynamic forces resulting in the dislodgement of restoration. Creating in vitro dynamic conditions similar to those in the mouth is difficult. Therefore, this study was done in static conditions to be able to focus on the interaction of surface roughness of abutment and the retention of crown. In this study only one type of abutment and cement were used. Various results can be obtained if other abutments or cements are tested for the interaction, because the interaction depends on the type of the material.

It has been demonstrated that bond strength can be significantly different based on cement type and surface roughness (27). Sandblasting the surface of abutment can increase resistance to dynamic lateral loading and the amount of this increase is different in various cements (28). According to the study of de Campos et al. (29), sandblasted and grooved abutment can create retentive strength 2.4 times more than machined abutment. Moreover, in this study, retentive strength in sandblasted and grooved abutments was similar. In a study by Kim et al. (30) provisional crowns were made on solid titanium abutments and cemented by TempBond. The retention between two sandblasted and bur-roughened abutments did not show significant difference. In the recently stated study and the present one, the type of abutment, temporary cement and test were the same. Different results show that in addition to abutment surface conditions and cement type, the material that the crowns are made of it can effect on retention.

The results of this study indicated that the retention of metal crowns on titanium abutments noticeably increases with factors such as roughening the surface of abutment with a diamond bur. This matter is very practical in clinics because it's very important to access a method which enables clinicians to cement crowns on titanium abutments with a long-term durability in spite of temporary cement. The suggestion for future study is to assess the effect of preparation of abutment, cement type, crown material and abutment materials

Conclusion

Surface modification of implant abutment by diamond bur improved the retention of metal crowns when cemented by TempBond.

Acknowledgment

This article is based on Farid Shiezadeh's undergraduate thesis (No. 2231). It has been supported in part by Dental Research Center and Vice Chancellor for Research of Mashhad University of Medical Sciences.

References

1. Simonis P, Dufour T, Tenenbaum H. Long-term implant survival and success: a 10-16-year follow-up of non-submerged dental implants. Clin Oral Implants 2010; 21: 772-7.
2. Krennmair G, Seemann R, Schmidinger S, Ewers R, Piehslinger E. Clinical outcome of root-shaped dental implants of various diameters: 5-year results. Int J Oral Maxillofac Implant 2010; 25: 357-66.
3. Lambert FE, Weber HP, Susarla SM, Belser UC, Gallucci GO. Descriptive analysis of implant and prosthodontic survival rates with

fixed implant-supported rehabilitations in the edentulous maxilla. J Periodontol 2009; 80: 1220-30.
4. Akça K, Iplikçioğlu H, Cehreli MC. Comparison of uniaxial resistance forces of cements used with implant-supported crowns. Int J Oral Maxillofac Implant 2002; 17: 536-42.
5. Breeding LC, Dixon DL, Bogacki MT, Tietge JD. Use of luting agents with an implant system: part I. J Prosthet Dent 1992; 68: 737-41.
6. Chee W, Felton DA, Johnson PF, Sullivan DY. Cemented versus screw-retained implant prostheses: which is better? Int J Oral Maxillofac Implant 1999; 14: 137-41.
7. Gunne J, Jemt T, Lindén B. Implant treatment in partially edentulous patients: a report on prostheses after 3 years. Int J Prosthodont 1994; 7: 143-8.
8. Kallus T, Bessing C. Loose gold screws frequently occur in full-arch fixed prostheses supported by osseointegrated implants after 5 years. Int J Oral Maxillofac Implant 1994; 9: 169-78.
9. Laney WR, Jemt T, Harris D, et al. Osseointegrated implants for single-tooth replacement: progress report from a multicenter prospective study after 3 years. Int J Oral Maxillofac Implant 1994; 9: 49-54.
10. Jemt T, Lekholm U. Oral implant treatment in posterior partially edentulous jaws: a 5-year follow-up report. Int J Oral Maxillofac Implant 1993; 8: 635-40.
11. Jemt T, Linden B, Lekholm U. Failures and complications in 127 consecutively placed fixed partial prostheses supported by Brånemark implants: from prosthetic treatment to first annual checkup. Int J Oral Maxillofac Implant 1992; 7: 40-4.
12. Zarb GA, Schmitt A. The longitudinal clinical effectiveness of osseointegrated dental implants: the Toronto study. Part III: problems and complications encountered. J Prosthet Dent 1990; 64: 185-94.
13. Sones AD. Complications with osseointegrated implants. J Prosthet Dent 1989; 62: 581-5.
14. 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: 111-5.
15. Bresciano M, Schierano G, Manzella C, Screti A, Bignardi C, Preti G. Retention of luting agents on implant abutments of different height and taper. Clin Oral Implants Res 2005; 16: 594-8.
16. Wahl C, França FM, Brito RB Jr, Basting RT, Smanio H. Assessment of the tensile strength of hexagonal abutments using different cementing agents. Braz Oral Res 2008; 22: 299-304.
17. Lawson NC, Burgess JO, Mercante D. Crown retention and flexural strength of eight provisional cements. J Prosthet Dent 2007; 98: 455-60.
18. Covey DA, Kent DK, St Germain HA Jr, Koka S. Effects of abutment size and luting cement type on the uniaxial retention force of implant-supported crowns. J Prosthet Dent 2000; 83: 344-8.
19. 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: 510-4.
20. Pan YH, Lin CK. The effect of luting agents on the retention of dental implant-supported crowns. Chang Gung Med J 2005; 28: 403-10.
21. Maeyama H, Sawase T, Jimbo R, et al. Retentive strength of metal copings on prefabricated abutments with five different cements. Clin Implant Dent Relat Res 2005; 7: 229-34.
22. Felton DA, Kanoy BE, White JT. The effect of surface roughness of crown preparations on

retention of cemented castings. J Prosthet Dent 1987; 58: 292-6.
23. Smith BG. The effect of the surface roughness of prepared dentin on the retention of castings. J Prosthet Dent 1970; 23: 187-98.
24. Juntavee N, Millstein PL. Effect of surface roughness and cement space on crown retention. J Prosthet Dent 1992; 68: 482-6.
25. Ayad MF, Rosenstiel SF, Salama M. Influence of tooth surface roughness and type of cement on retention of complete cast crowns. J Prosthet Dent 1997; 77: 116-21.
26. Carter GM, Hunter KM, Herbison P. Factors influencing the retention of cemented implant-supported crowns. N Z Dent J 1997; 93: 36-8.
27. Al Hamad KQ, Al Rashdan BA, Abu-Sitta EH. The effects of height and surface roughness of abutments and the type of cement on bond strength of cement-retained implant restorations. Clin Oral Implants Res 2010; 22: 638-44.
28. Wiskott HW, Belser UC, Scherrer SS. The effect of film thickness and surface texture on the resistance of cemented extracoronal restorations to lateral fatigue loading. Int J Prosthodont 1999; 12: 255-62.
29. de Campos TN, Adachi LK, Miashiro K, et al. Effect of surface topography of implant abutments on retention of cemented single-tooth crowns. Int J Periodont Res Dent 2010; 30: 409-13.
30. 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: 450-5.

Corresponding Author:
Mohammad Reza Nakhaei
Faculty of Dentistry and Dental Research Center
Vakilabad Blvd, Mashhad, Iran
P.O. Box: 91735-984
Tel: +98-511-8829501
Fax: +98-511-8829500
E-mail: mrn_nakhaei@yahoo.com