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The Effect of Implant Abutment Surface Modifications on the Retention of Cement Retained Restoration: An In-Vitro Study

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ABSTRACT:

Purpose: Retention is one of the most important factors for clinical success for any prosthesis. The most common technical complications of cement –retained implant supported fixed restorations are loss of retention. Surface modification of abutment and crown may increase the retentive strength of cemented crowns. Purpose of the present study was to compare the effect of implant abutment surface modifications on the retention of cement retained restoration.

Materials and Method: Forty solid titanium implant abutments (Top Implants) were divided into 4 groups. Ten abutments without surface modification (Group I) as supplied by the manufacturer, ten abutments with circumferential grooves (Group II) , ten abutments modified with an etchant (Group III) and ten abutments air-abraded with 50 microns aluminium oxide (Group IV)were used. Ni-Cr copings were fabricated for each abutment and luting cement (zinc phosphate cement) was used for cementing the copings. Using a Universal Testing Machine, tensile bond strength was recorded in Newton.

Results: Mean tensile bond strength of Group I, II, III and IV were found to be 300.97,491.41,339.80 and 317.05 Newton respectively. The values were statistically different from each other ($p<0.001$).

Conclusion: Abutments with circumferential retentive grooves showed the highest retention followed by abutments etched with an etchant, sandblasted abutments and then by abutments with no modifications.

Clinical Implications: Retention of the restoration depends on several factors like taper, surface area and height, surface finish and roughness as well as the luting agent used. Incorporation of circumferential retentive grooves, particle abrasion or acid etching can increase retention which is valuable especially in short clinical crown situations.

Introduction

A fixed prosthesis offers benefits from both a function and esthetics point of view and may be regarded as quite similar to a patient's own natural dentition when compared to removable treatment options. Dental implants are an effective and popular option for replacing missing teeth and form an important part of dental practice today.[14,1,22] Retention is one of the most important factor for clinical success for any prosthesis. Single crowns and bridge prostheses supported on implants are routinely used in dentistry. They can be cement-retained or screw-retained. Screw-retained restorations are associated with more complications than cement-retained restorations. Cement-retained restorations offer several advantages, including the

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elimination of unesthetic screw holes and greater resistance to porcelain fracture. According to literature, the most common technical complications of cement-retained implant supported fixed restorations is loss of retention, particularly when temporary cements and short abutments are used.[15] Several factors like taper, surface area and height, surface roughness influence the amount of retention in cement-retained restorations.[16,17,18] Camps TN et al , postulated that the retentive strength of restoration cemented with different cements could be influenced by the roughness and surface modifications of implant abutment in comparison to the uniform non-modified dental abutment surface.[24] Different implant abutment surface modifications namely air-borne particle abrasion, circumferential retentive grooves, acid etching have been advocated to enhance the retention of cement-retained implant-supported cast restorations. There are lot of studies about bond strength between crown and implant abutment luted with different luting agents.[8,25] But there are limited studies that evaluate the effect of surface treatment of abutments on the retention of cement-retained prosthesis. Therefore, the purpose of this study is to provide data on the retentive strength of prosthesis on the modified implant abutment surfaces.

Materials and Methods

Forty clear auto-polymerizing acrylic blocks of approximately 20x20x20mm were fabricated using a custom-made silicone mold. The implant analog was adjusted in the mold with the help of dental surveyor so that it was in the center of one of the surfaces as well as right angle to that surface. (Fig: 1) Forty solid implant abutments (Top implants) of 4mm height were used and their surfaces were modified. Out of forty, ten abutment surfaces were modified with circumferential horizontal retentive groove of 0.8mm width and 0.4mm depth using round carbide bur approximately 1mm from the cervical margin, the surfaces of another ten abutments were modified with an etchant (Kroll's reagent) for 30 seconds and another ten abutments were air-abraded in a sandblaster machine (UNIDENT) with 50 micron aluminium oxide particles and remaining ten abutment surfaces were not modified. These forty acrylic blocks having the implant abutments were divided into 4 groups of 10 abutments each. Group I abutments did not have any surface modification. In Group II the abutment surfaces were modified with circumferential retentive grooves. In Group III, abutments were modified with an etchant and in Group IV the abutments were air-abraded in a sandblaster machine. These implant abutments were fixed on the implant analog (already fixed in the acrylic block) by tightening the screw with the ratchet. Wax-up of the abutments was done to fabricate metal copings. Forty Ni-Cr copings were fabricated (10 in each group) with an attached loop on top of it to provide a flat surface to receive the load. Corresponding grooves were made on the internal surface of the metal copings of the abutments of Group II in a way that the grooves on abutment and coping face each other. All the copings of each group were luted on the respective abutments with zinc phosphate cement. (Fig/Table: 2) All the acrylic blocks with the luted copings on the abutments were placed in distilled water for 24 hours at room temperature for ageing. The tensile bond strength of the copings with the abutments were then tested using Lloyd's Universal Testing Machine.(Fig/Table:3) The copings were pulled from the abutment with a 500kg load cell at a crosshead speed of 5mm/min, until the coping dislodged from the abutment. The dislodging force representing the tensile bond strength was recorded in Newton.

Figure 1: Study Samples

Figure 2: Cement used in the study

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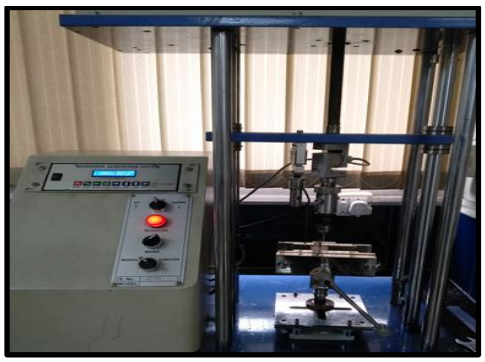

Figure 3: Universal Testing Machine

Results

The tensile bond strength as recorded from the Universal Testing Machine was tabulated and the mean value obtained (Fig/Table: 4). The values obtained were analyzed using ONE-WAY analysis. The One-way ANOVA test indicates the p-value 0.001 which is less than the set significance level of 0.05. It means the differences of the retentive values among the groups are significantly different statistically. The comparison of the mean force values between Group I, II, III and IV was done using the Post-Hoc Bonferroni test. (Table: 1)

	Force			
	Mean	Std. Deviation	F-value	p-value
Group III	339.80	58.49	10.058	0.001*
Group IV	317.05	103.26	*** Significant Difference**	
Group I	300.97	123.84		
Group II	491.41	32.39		

One-way ANOVA test

Table 2: Comparison of mean tensile bond strength of four test groups (I,II,III,IV)

		Mean Difference	p-value
Group III	Group IV	22.75	0.010*
Group III	Group I	38.84	0.003*
Group III	Group II	-151.61	0.001*
Group IV	Group I	16.08	0.046*
Group IV	Group II	-174.36	0.001*
Group I	Group II	-190.45	0.001*
			Significant Difference*

Post-Hoc Bonferroni Test

Inter group comparison of mean tensile bond strength of four test groups (I, II, III, IV) assessed. The dislodging force was significantly more in Group II in comparison to Group III which was significantly more than Group IV. The dislodging force of Group II, III & IV were significantly more than the Group I (Non modified surface).

Discussion

Dental implants are restored with two types of prostheses i.e., cement-retained and screw-retained. The screw-retained prosthesis was developed in response to the need of retrievability of restorations. Lately, the use of implant–supported cement-retained restorations has increased, due in part to the ability to optimize occlusal inter-digitation, enhanced esthetics and provide a passive fit [9,7,24]. The factors like abutment configuration and height of the abutment are determined by the particular clinical situation and cannot be changed as per the clinician's choice. In certain clinical situations, reduced abutment height due to limited inter-occlusal space can compromise retention of the cemented prosthesis. The surface modification of implant abutments could be done to increase the retention of the cement-retained implant supported cast restorations.

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The mean value of the tensile strength of Group I (Non modified) was 300.97N, Group II (circumferential retentive grooves) was 491.4N, Group III (acid etching) was 339.80N and Group IV (sandblasting) was 317.05N. When comparing the non- modified group with any of the other groups, the retentive values in all those groups were found significantly higher statistically. The study showed that retentive grooves, acid etching and sandblasting provided the implant abutment surface a significant increase in retentive strength. Marked differences in surface modifications exist among the three different abutment surfaces. Standard machined abutments are quite smooth but various surface modifications vary from each other as well as from unmodified abutments. On the basis of results obtained acid etching improved the retention of the copings more than sandblasting and unmodified abutments. The etching creates a surface with randomly distributed pits in a micron scale and enlarges the surface area which was found similar to the findings of Guizzardi et al.[5] The study demonstrated that adding circumferential grooves produces cement lock against dislodgement forces, thus increases the retention of the cemented copings in comparison to the other groups. The bond strength value in Group II with retentive grooves was higher than other groups which are similar to those reported by Maydan Le et al[24]. The influence of surface roughness on cemented casting restoration is controversial in the literature. On a dentin substrate, Witwer et al[5], found that crowns cemented on a smooth dentin surface had greater retention, but others showed that rough surfaces increased retentive strength.[6,7] Numerous studies have been carried out to test the effect of abutment surface modification on the retention of implant restoration. In this study, surface modification of implant abutment by means of circumferential grooves was found to be an effective method of improving the retention of cast crowns which was similar to the findings of de Campus et al[22], Lewinstein et al[8] and Sahu et al[6] whereas air-abrading standard machined abutments may be an easy, fast and less expensive clinical alternative to increase casting retention.

Conclusion

The circumferential retentive grooves group shows the highest bond strength followed by acid etching abutments followed by sandblasted abutments and then by unmodified abutments. The result showed circumferential retentive grooves having significant increase in retention of restoration as compared to no modification. Circumferential groove creates a local lock, and this may increase the length of the fracture line (plane) and have a greater effect on cements with a high modulus of elasticity such as zinc phosphate cements.

Limitations

In this study, the results probably cannot be generalized to different luting agents. Zinc phosphate cement has been indicated for the permanent cementation of implant–supported crowns[3,4] because it yields high retentive strength compared to most luting agents. Surface topography may have a greater impact on crown retention when cements with lower mechanical strengths are used. Therefore, further studies are warranted to evaluate the effect of sandblasting, acid etching, and grooving of implant abutments on casting retention under other experimental conditions (e.g. different abutment shapes[2], other luting agents) as well as in prospective clinical evaluation, to establish a predictable clinical protocol.

References

1. Dudley JE, Richards LC, Abbott JR: Retention of cast crown copings cemented to implant abutments. Aust Dent J 2008; 53: 332-9.
2. Michalakis K, Pissiotis AL, Kang K, Hirayama H, Garefis PD, Petridis H: The effect of thermal cycling and air abrasion on cement failure loads of 4 provisional luting agents used for the cementation of implant-supported fixed partial dentures. Int J Oral Maxillofac Implants 2007;22:569-74.
3. Sina Safari, Fereshteh Hosseini Ghavam, Parviz Amini, Kaveh Yaghmaei: Effects of abutment diameter, luting agent type, and re-cementation on the retention of implant-supported CAD/CAM metal copings over short abutments. J Adv Prosthodont 2018;10:1-7.
4. Akin H, Guney U: Effect of various surface treatments on the retention properties of titanium to implant restorative cement. Lasers Med Sci 2012;27:1183.
5. Reddy SV, Reddy MSN, Reddy CR, Pithani P, Kumar Sr, Kulkarni G: The infuence of implant abutment surface roughness and the type of cement

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on retention of implant supported crowns. J Clin Diagn Res 2015; 9:ZC05-7.

6. Nabaprakash Sahu: Implant-Supported Restoration with A Polymer Based Cement-A Surface Modifications for Retention. J Clin Diagn Res 2014;(1):239-242.
7. Zidan O, Fergusson GC: The retention of complete crowns prepared with three different tapers and luted with four different cements. J Prosthet Dent. 2003; 89: 565-71.
8. Lewinstein I, Block L, Lehr Z, Ormianer Z, Matalon S: An in vitro assessment of circumferential grooves on the retention of cement-retained implant-supported crowns. J Prosthet Dent 2011;106:367-72.
9. 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: 6-10.
10. In-Sung Yeo: Reality of Dental Implant Surface Modification. The Open Biomedical Engineering Journal, 2014, 8, 114-119.
11. 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: 116–121.
12. Felton DA, Kanoy BE, White JT: The effect of surface roughness of crown preparations on retention of cemented castings. J Prosthet Dent. 1987; 58: 292-96.
13. Wadhwani C, Hess T, Faber T, Piñeyro A, Chen CSK: A descriptive study of the radiographic density of implant restorative cements. J Prosthet Dent (2010);103:295-302.
14. Chaar MS, Att W, Strub JR: Prosthetic outcome of cementretained implant-supported fixed dental restorations: a systematic review. J Oral Rehabil 2011.
15. Tarica DY, Alvarado VM, Truong ST. Survey of United States dental schools on cementation protocols for implant crown restorations. J Prosthet Dent 2010;103:68-79.
16. Sheets JL, Wilcox C, Wilwerding T: Cement selection for cement-retained crown technique with dental implants. J Prosthodont 2008;17:9296.
17. 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.
18. Michalakis KX, Hirayama H, Pavlos D, Garefis PD: Cement-retained versus screw-retained implant restorations: a critical review. Int J Oral Maxillofac Implants 2003; 18:719-28.
19. Covey DA, Kent DK, Henry A. St. Germain Jr, Koka S: Effects of abutment size and luting cement type on the uniaxial retention force of implant-supported crowns.(2000) J Prosthet Dent. 2000;83:344-48.
20. S.M. Elsharkawy et al: Effect of various surface treatments of implant abutment and metal cope on their bond strength. Tanta Dent J 2015;12:235e240.
21. Kim Y, Yamashita J, Shotwell JL, Chong K-H, Wang H-L: 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.
22. 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.
23. Wadhwani C, Hess T, Faber T, Piñeyro A, Chen CSK: A descriptive study of the radiographic density of implant restorative cements. J Prosthet Dent 2010;103:295-302.
24. Shadid and sadaqa: A comparison between screw- and Cement-retained implant prosthesis. J Oral Implantol. 2012;1:6.
25. Hakan Akin: Retention properties of six different luting cements on titanium surface. Cumhuriyet Dent J. 2013;15:166-174.
26. Kaumudhi Kalla. Effect of Surface Modifications on the Retention of Implant-supported Cement-retained Crowns with Short Abutments: An In Vitro Study. J Contemp Dent Practice 22(12):1451-1456.