

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

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## 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- $\mu$ m 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 $\pm$ 8, 91.37 $\pm$ 7.19, and 58.61 $\pm$ 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.

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## 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- $\mu$ m 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 37°C 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
Within 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 $\pm$ SD	Tukey HSD test
a) Sandblasted	10	64.38 $\pm$ 8	a:b $P < 0.001$
b) Bur treated	10	91.37 $\pm$ 7.19	a:c $P = 0.19$
c) No surface treatment (control)	10	58.61 $\pm$ 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.

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