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Influence of abutment design on retention of metal copings cemented to implants

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ABSTRACT

Objective The study evaluated the influence of abutment design on the retention of implant-cemented metal copings.

Material and methods Two abutments of the same system with the same indications, height and the total occlusal convergence, but of different designs were evaluated. Ten RN synOcta abutments (Straumann, Waltham, MA) and ten RN titanium solid abutments (Straumann, Waltham, MA) were tightened to 35 Ncm on 20 implant analogs previously placed in resin blocks. Twenty plastic burnout copings were waxed, included, cast and machined by a single operator. Coping was inspected for surface irregularities using a stereomicroscope at 10x magnification, and then, they were cemented (Temp Bond NE, Kerr, Romulus, MI) with 5 kg load for 10 min. The samples were stored for 24 h in room temperature and 100% humidity and then subjected to pull-out test at a crosshead speed of 0.5 mm/min. The load required to dislodge each coping was recorded (kgf) and and mean values for each group statistically calculated. Means and standard deviations of loads at failure were analyzed using Student's *t*-test.

Results The mean load required to dislodge the copings showed by synOcta abutments (11.19 kgf) was statiscally higher than s solid abutments (10.18 kgf).

Conclusions: It was concluded that the abutment design influenced significantly the retention of metal copings.

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Introduction

Single crowns and cement-retained implant-supported prostheses are routinely used in dentistry. They can be cemented or screwed, and some facts, such as position of the implant, esthetics, ease of removal, retention, passivity and occlusion, should be considered in the selection of prosthesis retention method.[1,2] Each abutment design shows different load transition from the implant to the alveolar bone during mastication, swallowing and speaking [3].

A systematic review with multivariate analysis was evaluated the influence of the type of prosthesis and the retention mechanism on the complications in fixed prostheses on implants. This study considered "all fixed prostheses" as prosthesis type not reported or not known and found high rates of technical and biological complications for cement-retained prosthesis. The results of this study showed that screw-retained prostheses, full-arch prostheses, cantilevered prostheses and "all fixed prostheses" had significantly more technical complications than cemented prostheses with single unit and fixed partial. The incidence of technical and biological complications is dependent of prosthesis, retention type and abutment design.[4]

The use of temporary cements on the prostheses can be easily removed [5,6] since the retention is influenced by film thickness of cements, cementing technique and material used to coat the abutment screws.[7–10]

As in prosthetic preparations made in natural teeth, the protheses cemented to implants the height, total occlusal convergence and design of the abutments influence the retention of metal copings.[11,12] Single crown cemented on conical abutment does not affect negatively its mechanical strength, simplifies the design of metal-ceramic crown and improves retention.[13,14] However, there is no consensus regarding advantage of cemented prostheses over screwed prostheses. Although many authors state that clinical complications are most often associated with the screwed prostheses,[16–18] other studies showed no difference between these two types of prostheses.[19,20] Moreover, some studies

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presented clinical and biological superiority of cemented prostheses.[21].

The purpose of this study was to evaluate the influence of the design two different abutments on retention of implant-cemented metal copings. The hypothesis was that the abutment design influences the retention using a temporary cement.

Material and methods

Implant analogs were used, RN synOcta abutments (5.5 mm in height, Straumann, Waltham, MA) and RN titanium solid abutments (5.5 mm in height, Straumann, Waltham, MA).

Specimen preparation

The analogs were fixed in epoxy resin blocks 1.5 × 1.5 × 1.5 cm (Nema G10 Rod, Piedmont Plastics, São Carlos, Brazil). Standardization in each resin block was perfomed to prepare a niche for the fixation of analogs using tungsten carbide drill (5610045PM, Edenta, Hauptstrasse, Switzerland).

Thus, the resin blocks were positioned on base of dental surveyor (Bioart, São Carlos, Brazil) and the analogs on vertical rod itself. The niches were filled with acrylic resin (Jet, Clássico Produtos Odontológicos, São Paulo, Brazil) and the analogs inserted to platform limit and maintained in this position until the complete material polymerization (Figures 1 and 2).

The abutments were fixed on analogs with torque of 35 Ncm metal copings were made on abutments (Figure 3). A loop of wax was added to the occlusal surface of the cap to allow for subsequent pull-out test testing.[11] This pattern was duplicated to obtain samples of the two groups evaluated, and then casted using Ni–Cr alloy (AlbaDent, Cordelia, CA).

Cementation

For the cementation, the temporary cement Temp Bond NE (Kerr, Romulus, MI) was handled according to the manufacturer's instructions. Mixing and cementing procedures were carried out at room temperature by single operator. The cement was inserted through an insertion spatula (Duflex, Juiz de Fora, Brazil), in small quantities, on the axial inner walls of copings which were placed on abutments with a load of 5 kg maintained for 10 min.

Excess cement was removed using a scaler and samples stored in 100% humidity at 37 °C for 24 h. On abutments before the copings cementation, the screw was sealed with condensation silicone (Precise SX, Dentsply, Petrópolis, Brazil) to prevent the cement flow to inside of the abutments, involving only the abutments outer zone.

Figure 1. Solid abutment sample.

Figure 2. SynOcta abutment sample.

Pull-out test and statistical analysis

The samples were subjected to pull-out test using universal testing machine (Versat 2000, São José dos Pinhais, Brazil) at a crosshead speed of 0.5 mm/min until to metal coping displacement. The load required to dislodge each coping was recorded (kgf). The data for

Figure 3. Implant analog.

Table 1. Means and standard deviation (SD) values (kgf) of tensile strenght test.

Group	Means	SD
RN titanium solid abutments	10.18 b	0.85
RN synOcta abutments	11.19 a	1.11

Distinct letters showed statistical difference between groups (Student's *t*-test).

each group were submitted statistically to Student's *t*-test for independent samples ($p < 0.05$).

Results

With the pull-out test values (kgf) of each sample, Means and standard deviations of loads at failure were calculated and analyzed statistically (Table 1). The *p* value was 0.037, indicating significant differences between the groups evaluated.

Discussion

In clinical situations where there is reduced interocclusal space, the abutments height needs to be small. A space is manufactured between the abutment and the plastic cap, hence eliminating the need for die spacer. This built-in cement space measures 20 µm that is ideal cement thickness. The presence of this uniform cement space also decreases the need for casting adjustments. The abutments retention capacity can be an important factor for the success of cemented crowns. In the present study, it was selected the RN titanium solid and RN synOcta (Straumann, Waltham, MA) which have the same indications, height and total occlusal convergence, but different designs. It was used the Morse cone-connection implant/abutment, which has a higher torque than other connection types.[22–24]

For the prosthesis fixation, the abutments choice must follow the restorative treatment plan being modified according to position of the restorations margin, implant angle and screw access location.[1] In this study, the choice of abutments for cemented crowns was supported to several studies show significant advantages of these crowns over screw-retained crown as occlusion, esthetics, passive adjustment and mechanical strength of ceramics.[11,25,26]

Previous studies have shown for cemented crowns higher clinical success than screw-retained crowns in single-unit fixed dental protheses, being the screw loosening of most common complication related to abutments type.[5,11,15,17,27] However, other authors advocate the use of screw-retained crowns, considering the reversibility and ease to maintain successful of the prosthetic treatment.[2] However, the implants position must determine the fixing method of the crown,[2,28] since that an inadequate positioning between implant and prosthesis may lead to clinical complications.[29]

It should be emphasized that in small occlusal spaces, the retention of cemented prosthesis is jeopardized,[2] since the same mechanical properties of retention considered in the preparation of natural teeth for a crown are also applied to the prosthetic abutments on implants.[2,5] Additionally, the professional preference has relevance on the choice of the type of abutment. Some studies showed no difference in the clinical complications between the two retention methods.[30]

Hebel and Gajjar [5] have reported that the choice of screw-retained protheses is not justified based on the reversibility, because there are disadvantages associated to this type of attachment, mainly related to esthetics and occlusion, high cost and difficulty to realize the laboratory procedures. Moreover, it has been discussed the fact that the reversibility, the main advantage of screw-retained crowns, can also be obtained with cemented crowns using temporary cements.[5,11,12] Thus, it is justified to evaluate this kind of cement in studies that measure the retentive capacity of cement agents (temporary and/or permanent) in copings cemented on implant abutments.[7–10] In this study, Temp Bond NE (Kerr, Romulus, MI) was used as cement to the retention of metal copings. Futhermore, the behavior of temporary cements in crowns on implants is different of the behavior of these cements in natural teeth, since that occurs an significantly increase on retention.[12,30]

The results in this study supported the hypothesis tested that the abutment design influenced the retention using a temporary cement, since the synOcta abutments showed significantly higher tensile strength than solid abutments with same height and directions. Cehreli et al. [31] related to the solid abutments greater removal torque strength than synOcta abutments and greater difficulty to remove cemented crowns on synOcta abutments than solid abutments. The authors also suggested further studies to verify whether the results are also associated with abutment design.

In this study, the superior results related to RN synOcta abutments suggest an association between the abutment design and retention as evidenced in previous studies.[11,32] The retention of prosthetic crowns is significantly influenced both by the kind of cement and by the abutments design. Thus, the presence of the octagonal abutment base may have association with the mechanical retention. The RN synOcta abutments may be sandblasted with airborne-abrasive particles in the laboratory to create roughness and debris. Then, the cement is retained into cavities created by sandblasting increasing micromechanical retention and stabilizing the connection. However, this procedure is difficult be performed with solid abutments due it having an integral screw.[33] Moreover, the screw channel of the RN synOcta abutments can be modified to improve cement flow enhancing the amount of cement kept within the abutments (internal vent).[34]

According to Bresciano et al. [12] and Sadig and Al Harbi,[35] maintaining the same abutment geometry, its retentive capacity decreases with the height reduction, using both temporary or permanent cements, but in some clinicanl situations, this reduction is necessary due to the limited interocclusal space. According to manufacturer, RN synOcta abutments may be reduced up to 2 mm in height and the results in this study showed that these abutments possess as advantage of the possibility of greater height reduction than solid abutments and still maintain satisfactory retention.

The cement application technique may also have influenced the results of this study. The cement application is associated with the sealing ability of the restoration. Futhermore, different abutment designs may induce the flow of cements features, since a non-Newtonian cement behaves differently with respect to rheological properties such as volume and shape.[36]

The synOcta abutments presented superior tensile strength to metal copings when compared to solid using as luting agent a temporary cement. This procedure presents importante clinical significance because it increases the predictability of successful treatment, besides allowing the use of this type of abutment when the area to be rehabilitated has limited interocclusal space, increasing the indications of this prosthetic rehabilitation treatment.

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