Evaluation of Heat Transfer to the Implant-Bone Interface During Removal of Metal Copings Cemented onto Titanium Abutments

Umut Cakan, DDS, PhD[1]/Murat Cakan, PhD[2]/Cagri Delilbasi, DDS, PhD[3]

Purpose: The aim of this investigation was to measure the temperature increase due to heat transferred to the implant-bone interface when the abutment screw channel is accessed or a metal-ceramic crown is sectioned buccally with diamond or tungsten carbide bur using an air rotor, with or without irrigation. ***Materials and Methods:*** Cobalt-chromium copings were cemented onto straight titanium abutments. The temperature changes during removal of the copings were recorded over a period of 1 minute. ***Results:*** The sectioning of coping with diamond bur and without water irrigation generated the highest temperature change at the cervical part of the implant. ***Conclusion:*** Both crown removal methods resulted in an increase in temperature at the implant-bone interface. However, this temperature change did not exceed 47°C, the potentially damaging threshold for bone reported in the literature. *Int J Prosthodont 2016;29:290–292. doi: 10.11607/ijp.4561*

Removal of a cement-retained implant-supported restoration may be necessary when prosthetic complications such as loosening of an abutment screw or fracture of veneering ceramic occur. If the adhesive bond of the cement cannot be broken, the restoration can be removed by drilling through the restoration screw access channel or sectioning the restoration with a high-speed dental handpiece.[1] These interventions may generate frictional heat, and overheating the implant-bone interface along the implant body may result in bone necrosis leading to implant failure.[2]

Studies have been published on the effect of zirconia crown removal on heat transfer to the implant-bone interface, but equivalent studies on metal crown removal have not.[1,3] The purpose of this investigation was to measure the temperature rise due to heat transferred to the implant-bone interface when the abutment screw channel is accessed or a metal coping is sectioned buccally with diamond or tungsten carbide bur using an air rotor, with or without irrigation.

Materials and Methods

Type K thermocouples were twisted around a titanium implant (AnyRidge, MegaGen). Then the assembly was embedded into type III dental stone (Figs 1 and 2), which was considered to simulate the thermal behavior of bone since the thermal conductivity coefficients of bone and dental stone are proximate.[4]

A straight titanium abutment (EZ Post, MegaGen) with 2-mm gingival height was screwed onto the implant, and a 1-mm-thick cobalt-chromium (Co-Cr) coping was temporarily cemented.

The abutment screw channels were accessed through copings, or copings were buccally sectioned with either straight coarse (151 μm) diamond burs (S6837KR, Komet) or tungsten carbide burs (H35L, Komet) with or without water irrigation, using an air rotor with a rotation speed of 400,000 rpm in a water bath over a period of 1 minute (Fig 3). For each test modality, a new abutment, coping, and bur were used. The temperature changes were recorded via three thermocouples.

Results

The most rapid temperature changes were recorded by the thermocouple attached to the cervical part of

[1]Associate Professor, Department of Prosthodontics, School of Dentistry, Istanbul Medipol University, Istanbul, Turkey.
[2]Assistant Professor, Faculty of Mechanical Engineering, Istanbul Technical University, Istanbul, Turkey.
[3]Professor, Department of Oral and Maxillofacial Surgery, School of Dentistry, Istanbul Medipol University, Istanbul, Turkey.

Correspondence to: *Dr. Umut Cakan, Istanbul Medipol University, Department of Prosthodontics, School of Dentistry, Atatürk Bulvarı No: 27, 34083 Unkapanı, Fatih, Istanbul, Turkey. Fax: 90 212 5317555. Email: ucakan@medipol.edu.tr*

Fig 1 Type K thermocouples twisted around the cervical, middle, and apical parts of a titanium implant with a diameter of 4 mm and a length of 11.5 mm.

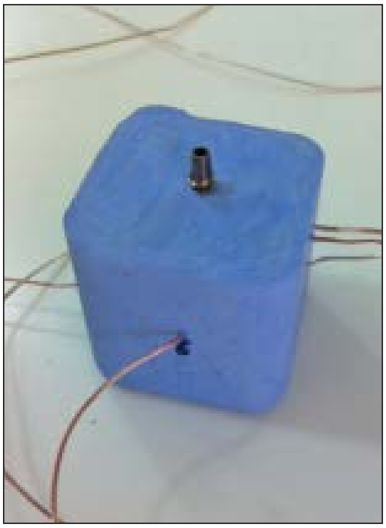

Fig 2 Implant and thermocouple assembly embedded in type III dental stone with additional thermocouples randomly placed into the stone block for ambient temperature control.

Fig 3 Experimental setup with a rubber dam at the cervix of the abutment and immersed in the thermostatically controlled water bath at 38°C.

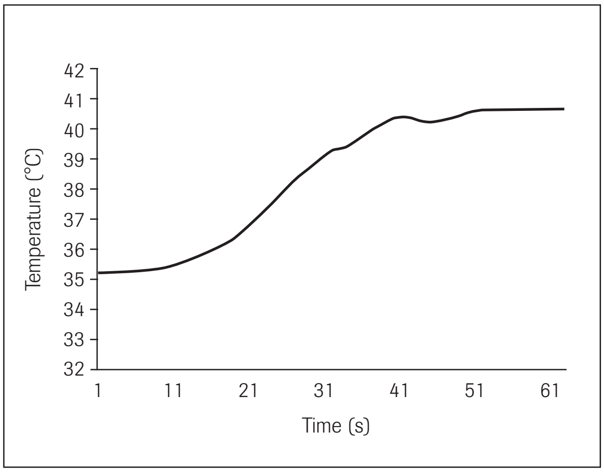

Fig 4 Representative temperature record during crown sectioning with diamond bur and without irrigation for 1 minute.

Table 1 Test Modalities and Maximum Temperature (°C) Measured Through Cervical Thermocouple

Method	Bur type	Irrigation	Maximum temperature measured (°C)
Coping sectioning	Diamond	+	35.05
Coping sectioning	Diamond	_	40.63
Coping sectioning	Tungsten carbide	+	35.06
Coping sectioning	Tungsten carbide	_	36.79
Screw accessing	Diamond	+	35.51
Screw accessing	Diamond	_	35.54
Screw accessing	Tungsten carbide	+	34.99
Screw accessing	Tungsten carbide	_	35.02

the implant. The highest temperature, 40.6°C, was observed during coping sectioning with a diamond bur and without water irrigation (Fig 4). The lowest temperature measured was 34.9°C for screw accessing with tungsten carbide bur with water irrigation (Table 1). The screw accessing method generated lower temperature changes at the implant-bone interface than the crown sectioning method. For both methods, the use of diamond bur generated higher temperature values in comparison with tungsten carbide bur.

Discussion

The temperature changes at the cervical part of the implant were more pronounced than those at the middle and apical parts of the implant, which was probably the result of the proximity of the bur or water irrigation.

The maximum increase in temperature for coping sectioning with diamond bur and without irrigation may be attributed to the lack of the cooling effect of irrigation and more friction generated by the coarse diamond bur.[5] On the other hand, when screw channel accessing was applied without irrrigation, the slight increase in temperature may be related to the relatively long distance between the occlusal drilling point and the cervical thermocouple.[1]

The application of continuous force for 1 minute was preferred to simulate an exaggerated period, which may provide information to clinicians about the maximum temperature anticipated during the cutting process.

Further investigations with different rotary instruments and burs with different grit sizes will contribute to the present findings.

Conclusions

Within the limitations of this study, both crown removal methods applied with diamond or tungsten carbide burs with or without irrigation in a period of 1 minute resulted in an increase in temperature at the implant-bone interface. However, this temperature change did not exceed 47°C, the potentially damaging threshold for bone reported in the literature.

Acknowledgments

The authors reported no conflicts of interest related to this study.

References

1. Mason AG, Sutton A, Turkyilmaz I. An investigation of heat transfer to the implant-bone interface when drilling through a zirconia crown attached to a titanium or zirconia abutment. J Prosthet Dent 2014;112:1119–1125.
2. Eriksson AR, Albrektsson T. The effect of heat on bone regeneration: An experimental study in the rabbit using the bone growth chamber. J Oral Maxillofac Surg 1984;42:705–711.
3. Huh JB, Eckert SE, Ko SM, Choi YG. Heat transfer to the implant-bone interface during preparation of a zirconia/alumina abutment. Int J Oral Maxillofac Implants 2009;24:679–683.
4. Park SH, Manzello SL, Bentz DP, Mizukami T. Determining thermal properties of gypsum board at elevated temperatures. Fire Mater 2010;34:237–250.
5. Gross M, Laufer BZ, Ormianar Z. An investigation on heat transfer to the implant-bone interface due to abutment preparation with high-speed cutting instruments. Int J Oral Maxillofac Implants 1995;10:207–212.