Efficiency and Thermal Changes during Implantoplasty in Relation to Bur Type

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ABSTRACT

Background: Implantoplasty is one of the options in treating peri-implantitis. The efficacy of the dental bur used can reduce the time needed for the procedure and, as a consequence, minimize the risk of overheating that can negatively affect the remaining bone surrounding the implant.

Purpose: The aim of this study was to evaluate the efficacy of three dental burs in removing implant substance (titanium) and to determine the amount of heat generated by each bur.

Materials and Methods: Four burs with different surface properties (diamond, diamond – Premium Line, carbide, and smooth bur – control [Strauss Co., Raanana, Israel]) were attached to a high-speed handpiece and applied to a titanium implant for a total of 60 seconds after cooling by water spray. Variations in temperature were recorded every 5 seconds, and the amount of implant substance removed (reduction in weight of the implant) was evaluated.

Results: The diamond Premium Line bur removed 59.24 mg; carbide, 29.39 mg; diamond, 11.35 mg; and smooth bur (control) 0.19 mg, statistically significant. Only minimum thermal changes (~1.5°C) were recorded for all four burs.

Conclusions: There are considerable differences in efficiency of different burs working on titanium. Selecting the proper bur can reduce working time. Under proper cooling conditions, implantoplasty does not generate excess temperature increases that can damage soft tissue or bone surrounding the treated implant.

KEY WORDS: dental burs, implantoplasty, implants, peri-implantitis, thermal change

INTRODUCTION

Peri-implantitis, which includes inflammatory and pathological changes in the peri-implant tissues, is a known complication with dental implants. The condition presents with red marginal soft tissues, bleeding upon probing, increased pocket depth around the implant, discomfort in mastication, radiographic loss of bone support, and, in severe cases, implant mobility. The etiology is because of bacteria invading through the surface of the implant and the pockets surrounding it. The most common are rods and mobile forms of Gram-negative anaerobes: *Prevotella intermedia*, *Porphyromonas gingivalis*, *Actinobacillus actinomycetemcomitans*, *Treponema denticola*, *Prevotella nigrescens*, *Peptostreptococcus micros*, and *Fusobacterium nucleatum*.[1,2] Other contributing factors found in non-smokers or who stopped smoking for ≥3 years were history of periodontitis, uncontrolled diabetes, and poor oral hygiene.[3] According to Ferreira and colleagues, the frequency of maintenance visits had no influence on the onset of the disease.[3] In a study by Roos-Jansåker and colleagues, smoking and history of periodontitis were risk factors for the development of this disease.[4] The prognosis of implants in patients with no history of periodontitis was

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DOI 10.1111/j.1708-8208.2011.00366.x

higher compared with those with history of the disease (96.5% vs 90.5%). Furthermore, peri-implantitis was more likely to appear in patients with a history of periodontitis (28.6% vs 5.8%).[5]

There is no consensus regarding the best treatment for peri-implantitis. Treatment of peri-implantitis includes mechanical debridement and local/systemic antibiotics, open flap debridement (OPD), OPD with bone grafting, OPD combined with laser therapy, and various resective surgical procedures with and without implantoplasty.[6–15] Romeo and colleagues observed that the preferred treatment might be to combine surgical debridement with implantoplasty.[14,15]

The implantoplasty method includes smoothing and polishing the rough surface and eliminating threads on implants with rotary instruments.[14,15] The aims of the procedure is decontamination of the implant surface and reducing the ability of bacterial plaque to adhere to the implant. Implantoplasty must be carried out with caution as it might cause overheating of the implant body and the surrounding bone. It was found that a change in mouth temperature caused by hot food or drink affects the temperature of the dental implant and surrounding bone as well.[16] The exothermic phenomenon of the setting acrylic material on implant abutments raises the temperature measured cervically 4 to 5°C.[17] Heat is produced also when preparing a titanium abutment with tungsten burs, which can eventually affect the surrounding bone.[18]

In daily practice, clinicians use two types of dental burs, carbide or diamond. The diamond burs differ from each other by design, carrier material, coating, and degree of roughness, which may affect the efficacy of the bur and the amount of heat produced. Other factors are working time, pressure produced, revolution per minute (rpm), and the turbine properties (torque). Carbide burs, composed of tungsten and carbon alloy, may be characterized by their high cutting efficiency.[19] The characteristics of the burs vary between the manufacturers, with no scientific evidence of which is more efficient.[20,21]

AIM

The aim of this study is to evaluate the efficiency of dental burs in removing implant substance and to assess the behavior of heat developed during cutting with a rotary instrument.

MATERIALS AND METHODS

Implants

Commercially available dental implants (grade 5 6AL-4V-titanium alloy, 6% aluminum and 4% vanadium) with a rough surface created by sandblasting and acid-etching procedures (Biocom, MIS Implants Ltd., Bar-Lev Industrial Park, Israel) were used for this study.

Burs and Handpiece

Four dental burs were selected for the study (Strauss Co., Raanana, Israel): regular diamond D1/medium grains (head 4 mm); carbide FGB 1557 (head 4.4 mm); Premium Line diamond D1PR/medium grains (head 4 mm), a system of gold-coated burs designed for precision tooth preparation; and a smooth surface bur active exclusively in the edge (end-cutting bur) as a control bur (Figure 1). The high-speed handpiece was powered at 340,000 rpm, with a water flow of 25 mL/mm and a permanent air pressure of 33 PSI (KaVo, Biberach, Germany).

Experimental Design

The weight of each implant was measured three times with scales able to measure micrograms (Precisa Gravimetics AG, Kietikon, Switzerland). A canal was prepared in the apical part of each implant through its vertical axis, creating space for the thermocoupler's electrode. Two levers were fixed to a metal plate with magnetic forces. The handpiece was immobilized on one lever. An implant was secured to the other with acrylic material, which allowed movement of the implant down

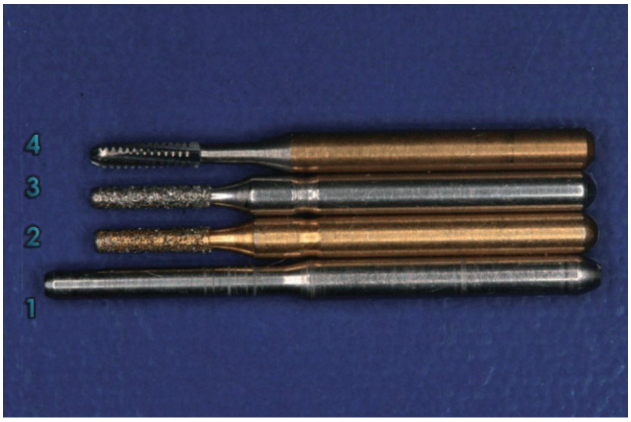

Figure 1 The four dental burs were (Strauss Co., Raanana, Israel) (1) a smooth surface bur; (2) Premium Line diamond D1PR/medium grains; (3) regular diamond D1/medium grains; and (4) carbide FGB 1557.

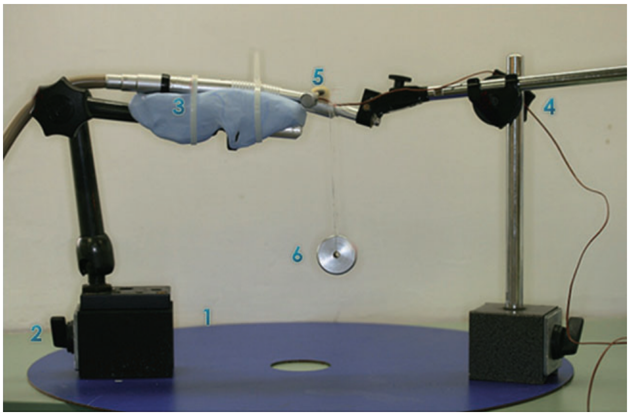

Figure 2 Experimental design: (1) plate; (2) magnetic base of arm; (3) handpiece secured to arm; (4) manageable arm holding the implant; (5) secured implant wired with electrode; and (6) 100 g pressure weight.

toward the bur on the handpiece (Figures 2 and 3). The thermocoupler (Almemo, Hlozkitchen, Germany) was connected to a computer and to an electrode placed in the dental implant canal, and isolated with composite material. A 100 g weight was connected with dental floss as close as possible to the implant to exert a constant force on the dental bur during the drilling operation. This specific weight was selected as it is known as the average pressure exerted clinically on a tooth, measured at the bur tip.[21] The levers were adjusted so that the active part of the drill was in contact with the implant throughout the experiments. The handpiece was placed in idle mode until the water spray cooled the implant. The thermocoupler was set on until the temperature reading stabilized (baseline). Immediately thereafter, the implant was drilled for 60 seconds during this

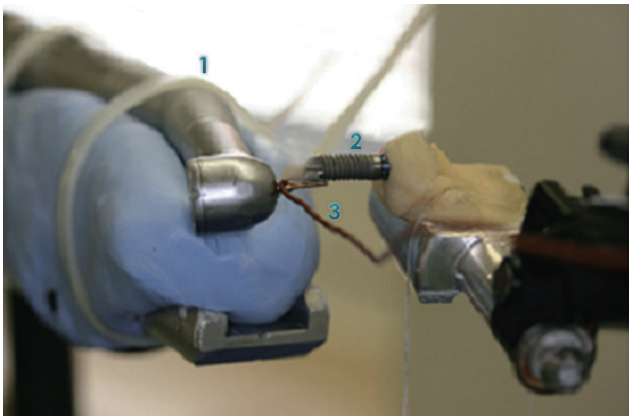

Figure 3 Experimental design: (1) handpiece secured to the fixed arm; (2) implant connected to a manageable arm; and (3) thermocoupler electrode wired to the implant.

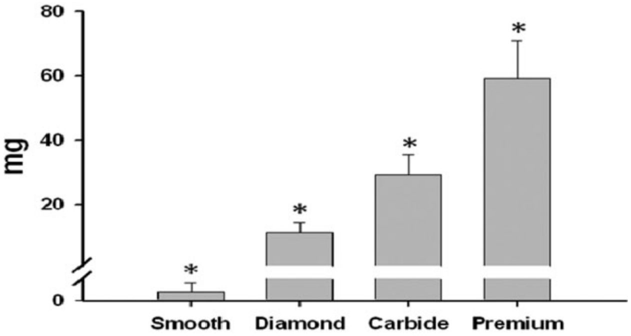

Figure 4 The mean amount of weight reduction. One-way analysis of variance $p < .05$ (mean values ± the standard deviation of the mean). Multiple comparison procedures (Student-Newman-Keuls method). *All groups are significantly different.

procedure; the temperature was measured by the thermocoupler, which provided a measurement every 5 seconds (total 12). The implant was weighed before and at the end of the session with the dental bur, with the decrease representing the amount of titanium removed. Each implant underwent four sessions, one for control and one for each of the three test burs.

STATISTICS

One-way analysis of variance was used for testing the significance of the difference between the treated groups. When significance was established, the intergroup differences were tested for significance by *t*-test with the Student-Newman-Keuls method correction for multiple testing. The level of significance was determined at $p < .05$.

RESULTS

The mean amount of weight reduction over 60 seconds was: smooth (control) bur, 0.19 mg; diamond bur, 11.35 mg; carbide bur, 29.39 mg; and the premium bur, 59.24 mg. The differences between the groups were statistically significant ($p < .05$) (Figure 4).

Prior to contact between the implant and the bur, the water spray decreased the temperature of the implant by 1.5°C compared with the baseline in all groups. When the burs contacted the implant during the first 5 seconds, a temperature increase of 1.5 to 1.8°C from baseline was observed in all four groups. After 10 seconds, the temperature decreased down to baseline. The temperature remained at baseline value throughout the rest of the 60-second test period, with no statistical differences between the groups (Figure 5).

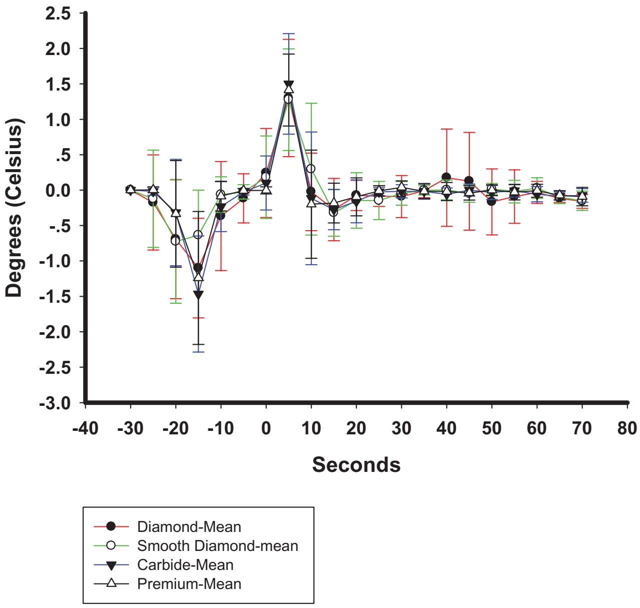

Figure 5 Temperature changes for the different burs tested.

DISCUSSION

The present study statistically demonstrated the significant differences in the cutting efficacy of four dental bur surfaces on titanium implants, with our results showing that the premium diamond bur removed the largest amount of implant substance after 60 seconds, followed by carbide, regular diamond, and control. The premium dental bur is from a new line designed for precision grinding of teeth. The shank is plated using a unique method with diamond particles spread in a homogenic way. More diamond particles touch the surface of the implant at a given time, which increases the cutting efficiency of the burs. The superior cutting efficacy of the premium diamond burs also helps reduce the time the implant is exposed to the procedure, reducing thermal changes and micromovement. The carbide bur was found to be more efficient than the regular diamond bur, as was reported previously by Ercoli and colleagues.[22]

The implantoplasty procedure is a clinical challenge because of the risk that the heat may have a negative effect on the bone and tissue surrounding the implant. The threshold level for heat-induced cortical bone tissue necrosis is 47°C for 1 minute.[23] Heat shock at 42°C induced transient changes in osteoblasts.[24] Other studies also showed a correlation between the temperature in the coronal part of the implant and in the surrounding bone.[16–18]

The present study showed that implantoplasty under appropriate water spray conditions resulted in only minor thermal changes (1.5°C) and, therefore, can be considered a safe procedure. Gross and collegues showed similar thermal changes, 1°C rise, when preparing a titanium abutment with a diamond bur.[18]

The thermal changes under the tested conditions were almost equal for the four burs examined, with no significant differences. However, the cutting efficacy of the burs was significantly different. These results showed that temperature changes are not related to the cutting efficacy of the bur, which was more related to the procedure itself, the turbine, and water flow rate.

The authors believe that the cutting efficiency will be exactly the same in routine clinical conditions but cannot be as decisive regarding the similar thermal behavior in situ. This issue needs to be further developed and investigated in another study.

In conclusion, there are considerable differences in efficacy of different burs working on titanium. Selecting the proper bur can reduce working time and micromovement of the implant. In addition, under proper cooling conditions, implantoplasty does not generate excess temperature increases that can damage soft tissue or bone surrounding the affected implant.

ACKNOWLEDGMENTS

The implants used in this study were supplied by MIS Implants Technologies Ltd., Israel. The dental burs were supplied by Strauss Co., Raanana, Israel.

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