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Phosphoric Acid Increases the Porosity and Extends the Contact Area of Dental Osseo integrated Implants

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Abstract— *The surface treatments are performed in dental implants in order to increase the chemical and mechanical connection between the implant and bone, favoring the stability of implant-supported prostheses. The aim of this study was to characterize dental implant surfaces treated with 37% phosphoric acid. Implant surfaces were evaluated divided into groups of fifty samples being distributed in: porcelain samples without treatment; metal samples without treatment; porcelain samples with treatment with 37% phosphoric acid for 30 seconds; metal samples treatment with phosphoric acid at 37% for 30 seconds; porcelain samples with treatment with 37% phosphoric acid for 60 seconds; metal samples with treatment with 37% phosphoric acid for 60 seconds. The samples were characterized by Scanning Electron Microscopy. After the phosphoric acid treatment porosity changes were observed and expanding the contact area. The results show benefits of using phosphoric acid, as a surface with increased roughness; this is desired to occur matrix deposition and growth of bone tissue and facilitates the fixation of implant-supported prostheses.*

Keywords— Dental implants, phosphoric acid, porosity.

I. INTRODUCTION

A dental implant is a treatment to replace missing teeth has become an integral treatment modality in Odontology. Dental implants have several advantages in relation to conventional fixed partial denture. Among them it is possible to highlight: high success rate (over 97% for 10 years); reducing the risk of cavities and endodontic problems of adjacent teeth; best bone maintenance in edentulous site and decreased sensitivity of the adjacent teeth. It is a structure located in the tissues under the oral mucosa and / or the periosteum and / or within or through the bone to provide support and retention for a dental prosthesis (Gupta; Weber, 2017).

For biocompatibility and implant success determining factors are considered: the geometry, surface condition, the general state of health of the host, the surgical technique and control of the mechanical load after installation of the implant. Several studies have sought to compare different surface treatment methods and their influence on the mechanisms involved in the acceptance or rejection of the implant, as well as the cellular response and intensity of inflammation (Brandão, 2010; Fugazzoto; Vlassis, 2007; Kang, 2009).

The increased contact area between bone and implant can be obtained by changing the topography or by increasing the surface roughness of the implant (Anselme et al., 2000). The relationship between the success of the implant and the cement used for fixation of the prosthesis is still not fully understood. Despite the stage of cementing is one of the stages of the clinical protocol indirect restorative, which was modified in the transition from the use of conventional systems for so-called aesthetic-adhesive systems or metal-free, in the literature, there are few works related to mechanical and each adhesive system, as well as the properties and limitations of adhesives and cementing systems that can lead to early failure of implant-supported prostheses (Garofolo, 2005).

Thus, surface treatment process can be an alternative to the success of the implant. Such treatments may be added through methods where the material added to the implant surface, or subtracting, when removing part of the surface layer (Groismam et al., 2005).

One method of surface treatment by subtracting is the acid attack (Hsu et al., 2007), with the machined metal implants are immersed in an acid, in pure form or in

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solution, and maintained for a given time interval , with small ridges or retention surfaces (Nagem Filho, 2007).

The aim of the study was to characterize surfaces of dental implants of different materials, treated with 37% phosphoric acid by volume.

II. MATERIALS AND METHODS

For the treatment effect was considered the inner surface of the prosthetic implant and the implant external metal. The concentration of phosphoric acid used was 37% and treatments were performed two times, 30 seconds and 60 seconds. A control was also performed without the treatment with phosphoric acid.

Three hundred samples were prepared, divided into six groups, with fifty units in each sample. Where: Group 1: porcelain samples without treatment with phosphoric acid at 37%; Group 2 metal samples without treatment with phosphoric acid at 37%; Group 3: porcelain samples treatment with phosphoric acid at 37% for 30 seconds; Group 4 metal samples treatment with phosphoric acid at 37% for 30 seconds. Group 5: porcelain samples with treatment with 37% phosphoric acid for 60 seconds; Group 6 metal samples with treatment with 37% phosphoric acid for 60 seconds.

The porcelain samples were prepared mimicking the buccal surface of the upper incisor teeth, having its inner surface received etching with phosphoric acid at 37% for 60 seconds, leaving an area not in contact with the acid to indicate the difference in opacity between the treated area and the untreated area.

The metal inner surface received etching with 37% phosphoric acid for 60 seconds, leaving an area not in contact with acid, to indicate the difference in opacity of treated area and untreated area.

Using scanning electron microscopy the surface was mapped and the data registered in photomicrographs.

III. RESULTS

After treatment of the samples with phosphoric acid application at 37% were observed on the surface changes as a function of time. The exposure to phosphoric acid made more opaque surface. Figure 1 shows the differences between the samples without attack on the inner surface of the prosthetic implant and the external surface of the implant, in the presence or absence of phosphoric acid treatment.

What is observed is that surfaces of both porcelain and metal before the treatment with 37% phosphoric acid are smoother and therefore more homogeneous (A), where these surfaces are exposed to the treatment with phosphoric acid 37% for 30 seconds characteristics of surfaces are becoming opaque and therefore less bright (B), however the images in (C) after the surfaces were exposed to treatment with phosphoric acid at 37%, for 60 seconds, the surfaces have much more opaque and less bright, suggesting that the higher the greater exposure to acid changes in their structure.

It is observed that after 60 seconds of treatment with phosphoric acid the surfaces of both porcelain and metal feature are changed, as indicated by arrows in Figure 1.

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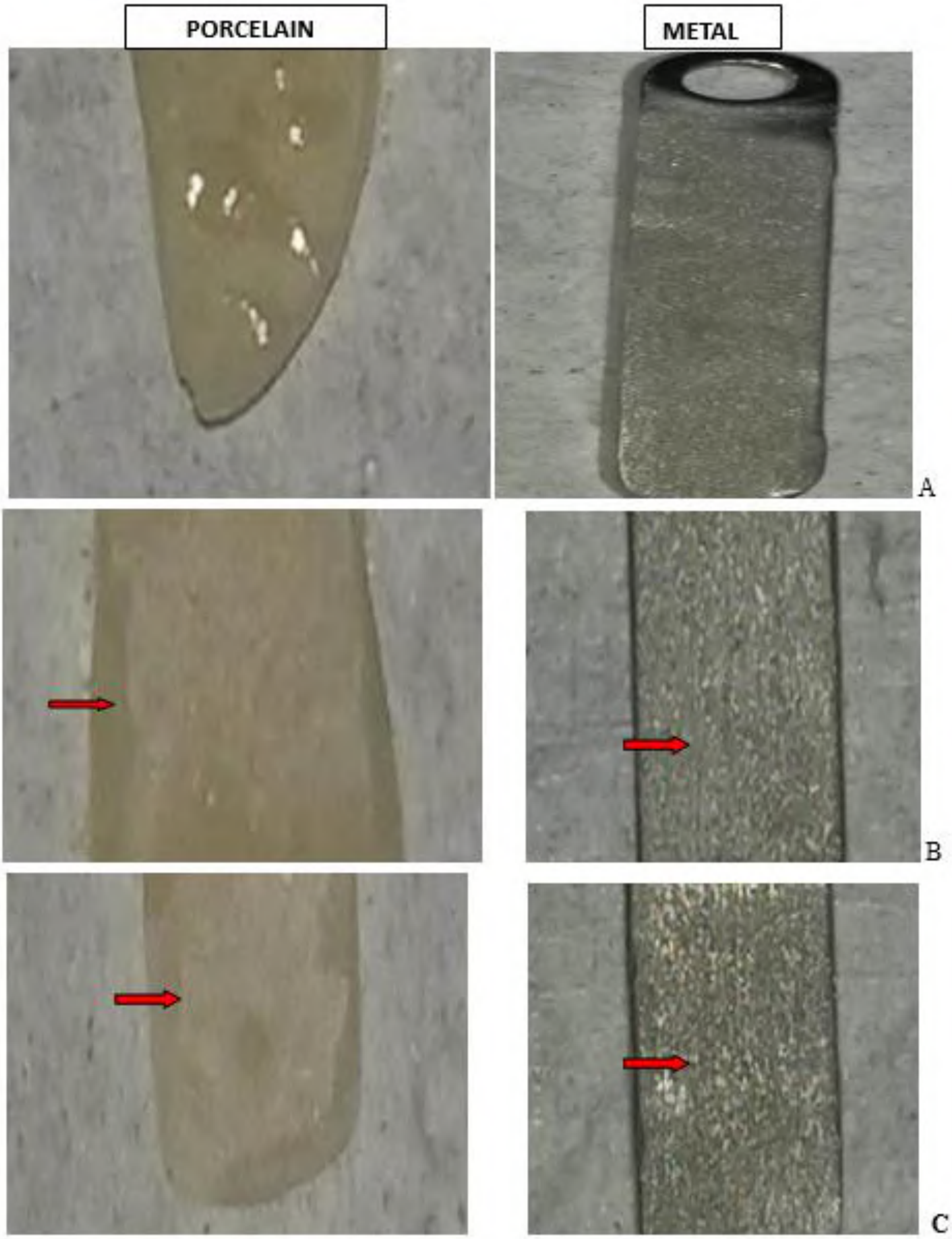

Fig. 1 -1: Visual appearance of porcelain and metal samples without treatment with phosphoric acid attack (A) with phosphoric acid treatment for 30 seconds (B) and treatment with phosphoric acid for 60 seconds (C).

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In Figure 2 is the analysis of the porcelain surfaces treated and not treated by phosphoric acid at 37% in the scanning electron microscope, there is an area treated with strong porosity.

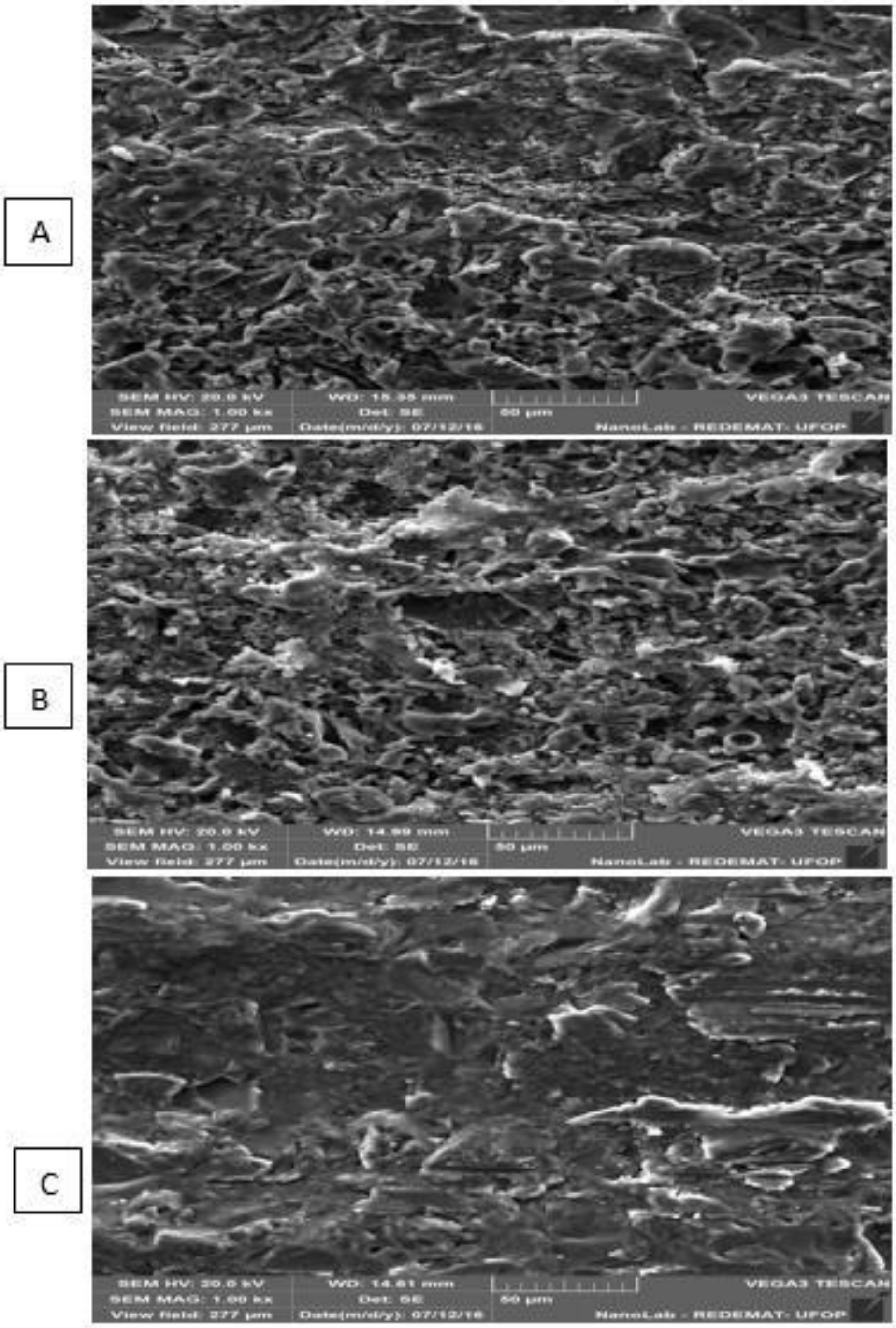

Fig.2: Photomicrograph of porcelain surfaces; in A the untreated, in B treated with phosphoric acid and after 30 seconds and in C treated with phosphoric acid after 60 seconds (SEM image at 1000x magnification).

Figure 3 refers to the photomicrographs of untreated and treated metal surfaces with phosphoric acid. It is noted that the treatment in metal was effective for increasing the contact area with cement, which may improve the attachment the prosthesis.

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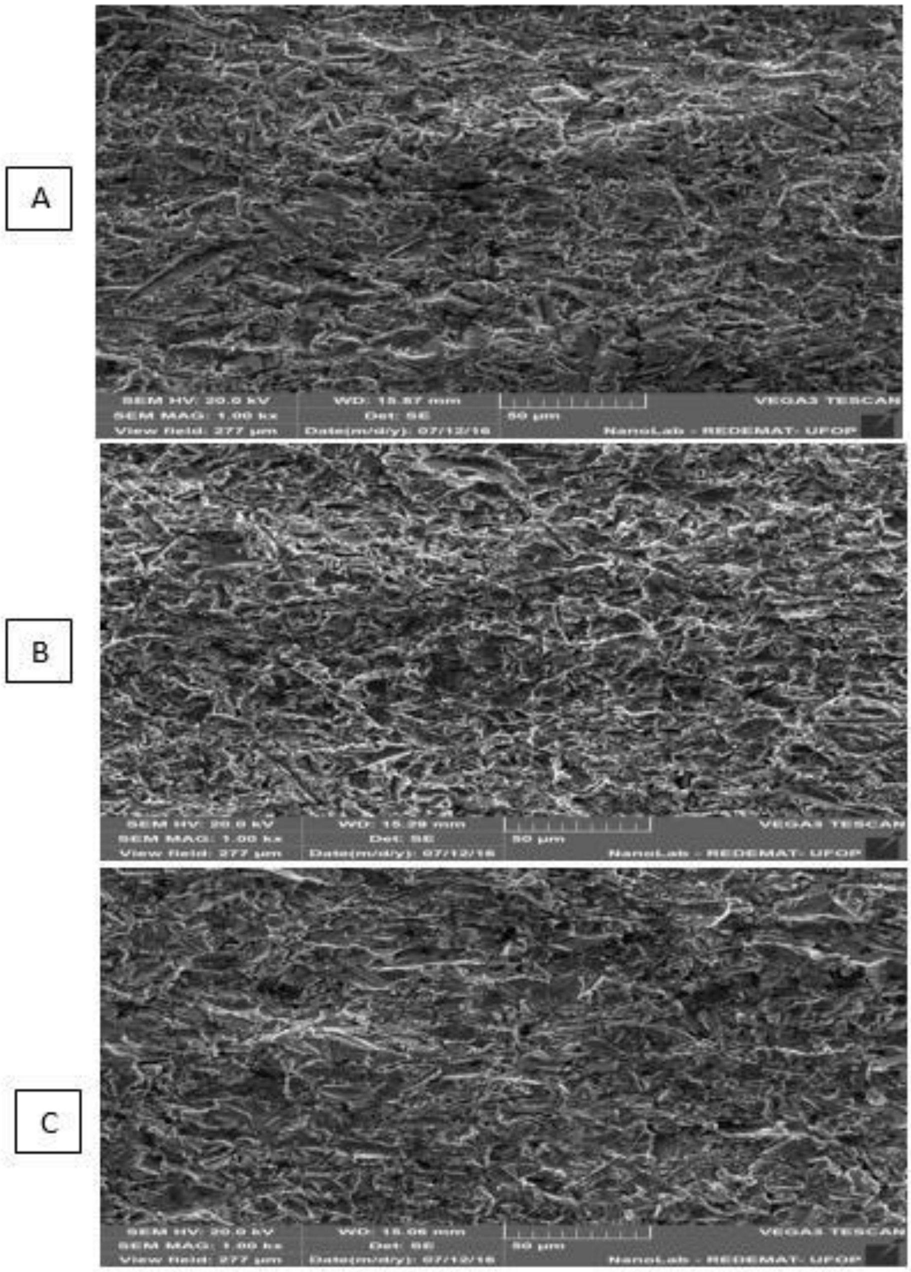

Fig.3: Photomicrograph of metal surfaces; in A the untreated, in B treated with phosphoric acid and after 30 seconds and in C treated with phosphoric acid after 60 seconds (SEM image at 1000x magnification).

IV. DISCUSSION

The need for development of dental treatments to supply the missing teeth stimulated the search for studies of the production of prosthetics they need to have a restraint system that provides retention and stability of the prosthetic element, which allows the patient to use with functionality and aesthetics.

The treatment of the internal surfaces of the prosthetic implant can directly influence the physical and mechanical properties of the joint prosthesis / implant, culminating in a reduced line of cementation and better fixation of prosthetic implants for dental use.

According to the data obtained, the implant surfaces treated with phosphoric acid undergo structural changes which can influence the success of the dental implant.

Scanning electron microscopy analysis revealed that the surfaces of both metal and porcelain implants have undergone considerable surface changes with increased porosity. The breakage caused by phosphoric acid on the surface suggests an increase in porosity, expansion of the contact area of the cement fixer and imbrication of the favored cement, which may increase the anchorage of the prosthesis over the implant.

The different surface pretreatment (chemical, mechanical, or both) to the surfaces that make up the cementing line are proposed in the literature (Lohbauer et al, 2008;

Kitayama et al, 2009; Amaral et al, 2014; Bottino et al, 2014; Rippe et al, 2015).

Studies on the resistance of cemented crowns with different roughness after treatment with aluminum oxide showed that on smooth surfaces cemented crowns had a lower resistance drift as compared surfaces with grooves. The rugosity after treatment with acids can generate increased resistance in cemented crowns (Campos et al., 2010).

The treatment with phosphoric acid of the surface which the implant can increase the offset resistance and the acid solution can clean the surface and create micro roughness on the surface, improving adhesion to cement.

It is noteworthy that the pretreatment of surface enhances the retention of the implant crowns for dental use. Thus, preparation of surfaces that were in contact with the zinc phosphate cement can result in significantly increased retentive strength values when compared to untreated surface.

In the clinical monitoring of patients rehabilitated with cemented and screwed prostheses on implants showed clinical success and prosthetic these types of prostheses. The success rate of treatment was 96.4%, with no differences between patients rehabilitated with cemented prostheses and rehabilitated patients with screwed prosthesis (Sherif et al, 2011).

On the other hand, another study reported clinical complications associated with cemented prostheses on dental implants use, requiring rigorous clinical controls, to check for changes in the peri-implant tissue. The main cause of the observed problems is excess cement and suggest that it is necessary rigorous clinical controls, so that they can examine the changes in the peri-implant tissue in their early and act quickly to avoid a major complication (Pauletto et al, 1999).

V. CONCLUSION

The results obtained allow us to conclude that there is a beneficial action of phosphoric acid when applied to implant surfaces, causing porosity changes and expansion of the contact area of the surface, which may have important clinical implications.

REFERENCES

[1] Amaral R. Rippe M. P. Oliveira B. G. Cesar P. F. Bottino M. A. Valandro L. F. (2014). Evaluation of tensile retention of YTZP crowns after long-term aging: Effect of the abutment substrate and Y-TZP surface conditioning. Operative Dentistry. 39(6): 619-626.

[2] Anselme K. Bigerelle M. Noel B. Dufresne E. Judas D. Iost A. Hardouin P. (2000). Qualitative and quantitative study of human osteoblast adhesion on materials with various surface roughnesses. Journal of Biomedical Materials Research. 49(2): 155-166.

[3] Bottino M. A. Bergoli C. Lima E. G. Marocho S. M. Souza R. O. Valandro L. F. (2014). Bonding of Y-TZP to dentin: Effects of Y-TZP surface conditioning, resin cement type, and aging. Operative Dentistry. 39(3): 291-300.

[4] Brandão M. L. Esposti T. B. D. Bisognin E. D. Haran N. D. Vidigal G. M. Conz M. B. (2010) Superfície dos implasntes osseointegrados x resposta biológica. Implantnews. 7(1): 95-101

[5] Campos T. N. Adachi L. K. Miashiro K. Yoshida H. Shinkai R. S. Neto P. T. et al. (2010). Effect of surface topography of implant abutments on retention of cemented single-tooth crowns. International Journal of Periodontics & Restorative Dentistry. 30: 409-413.

[6] Fugazzotto P. A. Vlassis J. (2007). Report of 1,633 implants in 814 augmented sinus areas in function for up to 180 months. Implant Dentistry. 16: 369-378.

[7] Garófolo J. C. (2005). Desvendando a Cimentação Adesiva (parte 1). Alianews, Informativo interno do Laboratório Aliança N. 03- Set.

[8] Groisman M. E. Vidigal Junior G.M. (2005). Tipos de superfícies de implantes. Periodontia e Implantodontia - Atuação clínica baseada em evidências científicas. Sobrape. 14: 1-14.

[9] Gupta R. Weber K. K. (2017). Dental Implants. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing.

[10] Hsu S. H. Liu B. S. Lin W. H. Chiang H. C. Huang S. C. Cheng S. S. (2007). Characterization and biocompatibility of a titanium dental implant with a laser irradiated and dual-acid etched surface. Biomedical Material Engeering. 17: 53-68.

[11] Kang B. S. Sul Y. T. Oh S. J. Lee H. J. Albrektsson T. (2009). XPS, AES and SEM analysis of recent dental implants. Acta Biomaterialia. 5: 2222-2229.

[12] Kitayama S. Nikaido T. Maruoka R. Zhu L. Ikeda M. Watanabe A. Foxton R. M. Miura H. Tagami J. (2009). Effect of an internal coating technique on tensile bond strengths of resin cements to zircônia ceramics. Dental Materials Journal. 28: 446-453.

[13] Lohbauer U. Zipperle M. Rischka K. Petschelt A. Müller F. A. (2008). Hydroxylation of dental zirconia surfaces: characterization and bonding potential. Journal of Biomedical Materials Research Part B Applied Biomaterials. 87(2): 461-467.

[14] Nagem Filho H. Francisconi P. A. S. Campi Júnior L. Fares N. H. (2007). Influência da textura superficial dos implantes. Odonto Ciência. 22(5): 82-86.

[15] Pauletto N. Lahiffe B. J. Walton J. N. (1999). Complications associated with excess cement around crowns on osseointegrated implants: a clinical report. International Journal of Oral and Maxillofacial Implants. 14(6): 865-868.

[16] Rippe M. P. Amaral R. Oliveira F. S. Cesar P. F. Scotti R. Valandro L. F. Bottino M. A. (2015). Evaluation of tensile retention of Y-TZP crowns cemented on resin composite cores: Effect of the cement and Y-TZP surface conditioning. Operative Dentistry. 40(1): E1-E10.

[17] Sherif S. Susarla S. M. Hwang J. W. Weber H. P. Wright R. F. (2011). Clinician- and patient-reported long-term evaluation of screw- and cement-retained implant restorations: a 5-year prospective study. Clinical Oral Investigations. 15: 993-999.