Surfaces in Implantology: Characteristics of the main Brazilian implants

doi: http://dx.doi.org/10.1590/2237-650X.7.4.046-051.car

Introduction / The superiority of rough-surface implants over machined ones seems to be consensual today. Different surface treatment methods have been developed to improve potential tissue response. This study critically reviewed the information that some Brazilian companies provide to dentists about the characteristics of surface treatment, methods as well as the recommended loading time, and analyzed whether these important data are based on scientific findings. Methods / Six Brazilian companies, Conexão®, Kopp®, Neodent®, P-I Branemark®, S.I.N® and Titaniumfix® received a questionnaire about their products and respective surface treatment, recommended loading time and scientific evidence. Results / Different treatment methods were reported: acid etching, abrasion followed by acid etching, and plasma immersion ion implantation (PIII). According to the information provided, loading time ranged from 1 to 6 months. Conclusions / Although some companies conduct scientific studies to evaluate their implants, this study found that there was no scientific evidence to support the recommended loading times and that the information provided was not accurate.

Alexandre da Silveira **Gerzson**
Doctorate student in Oral and Maxillofacial Surgery and Traumatology, Catholic University of Rio Grande do Sul (PUC-RS).

Cláudio Ayres **Peres**
Specialist in Implantodontics, Ingá College (UNINGÁ).

Márcio Borges **Rosa**
PhD in Implantodontics, São Leopoldo Mandic College of Dentistry.

Eduardo Poester **Fetter**
Professor, Specialization in Implantodontics, UNINGÁ.

Luiz Antônio **Marchioni**
Msc in Dentistry, Brazilian Lutheran University (ULBRA). Professor, Specialization in Implantodontics, UNINGÁ.

How to cite this article: Gerzon AS, Peres CA, Rosa MB, Fetter EP, Marchioni LA. Surfaces in Implantology: Characteristics of the main Brazilian implants. Dental Press Implantol. 2013 Oct-Dec;7(4):46-51. doi: http://dx.doi.org/10.1590/2237-650X.7.4.046-051.car

Submitted: July 03, 2013 - **Revised and accepted:** September 08, 2013

Contact address: Alexandre da Silveira Gerzson
Rua Dona Laura, 87/506 – CEP: 90430-091 – Porto Alegre/RS — Brazil – Email: alexandregerzson@gmail.com

The authors inform they have no associative, commercial, intellectual property or financial interests representing a conflict of interest in products and companies described in this article.

INTRODUCTION

Implantology has undergone constant changes not only to improve tissue response, but also to shorten treatment time. Initial studies about osseointegration used machined implants fabricated from commercially-pure titanium (grades 1 and 2).[1] As studies advanced, researchers realized that modifications on implant surface topography affect the response of adjacent bone,[2] promote greater fibrin integration and interlacing, and create paths for the migration of adjacent cells towards the surface, which favors osteogenesis as a result of increasing direct contact with the implant surface.[3] These changes speed up the process of secondary stability and shorten loading time.

Different implant surface treatments have been developed to accelerate osseointegration and strengthen the integrated interface. The most common methods are: abrasion; laser sintering; anodization; acid etching; and abrasion combined with acid etching.

The constant development of implant surface properties has changed clinical protocols. This study critically analyzed the information provided by some Brazilian companies about the characteristics of treatments used to modify implant surfaces, as well as the recommended loading time. It also analyzed whether these companies have conducted scientific studies using their implants and whether the information provided is based on study findings.

MATERIAL AND METHODS

A questionnaire was used to evaluate the type of surface treatment and the recommended loading time of some of the implants manufactured in Brazil. No other method was used to collect data. Six companies were selected to respond the questionnaire: Conexão®, Kopp®, Neodent®, P-I®, S.I.N® and Titaniumfix®. These companies were contacted by phone and e-mail, and the questionnaires were answered by their scientific consultants.

The questionnaire comprised the following questions: (1) What is the commercial name of the implant surface of your company?; (2) How is the implant surface treated?; (3) What is the recommended loading time, considering time for osseointegration in the maxilla and mandible?; (4) Based on what factors was loading time defined?; and (5) Are there any scientific studies or publications about the surface treatment used by your company? Are these studies available for examination?

RESULTS

Out of the six companies contacted, only S.I.N® did not answer the questionnaire. The answers given by the other companies are summarized in Table 1.

Conexão® names their implant surfaces as Porous and Vulcano Actives. They reported using total acid immersion to modify implant surface topography, with a specific time and temperature set for each type of implant, not disclosed because of business confidentiality. The company recommends the Porous surface for all types of bone density, and a loading time longer than 2 months. Vulcano Actives, in turn, is recommended for bones type 2 and 3, and not recommended for type 1. The recommended loading time is 1 month. According to the company, loading times have been defined in agreement with studies found in the literature. The company made available four studies which had been previously conducted with the aforementioned studies and surface treatments.[4-7]

Kopp® reported that their surfaces receive some type of chemical treatment. Their process is conducted in agreement with the following rules issued by the Brazilian Association of Technical Specifications (ABNT): NBR 12932 — surgical implants, metal supplies, surface preparation and marking; and NBR 14233 — surgical implants, metal supplies, cleaning and pickling of titanium and titanium alloy surfaces. They recommend a loading time of 3 to 5 months and highlight that the exact time depends on each clinical case and patient follow-up. The length of loading time was associated with clinical, surgical and product (implant) factors, such as: contraindications; diagnosis, planning and adequate surgical technique combined with biosafety; correct sequence of burs; administration of pre and postoperative medication; engineering, quality and product origin. Kopp® made reference to two studies,[8-9] which, however, were not conducted with implants manufactured by their company.

Neodent® names their implant surface treatment as Neoporos. The surface is prepared by two processes: abrasion and acid etching. They recommend a

loading time of 2 to 3 months based on bone repair and bone-implant contact (BIC), as estimated by the company. In the item about studies found in the literature, they claimed that a study about loading time using their own implants is to be published soon.

P-I® names its surfaces as Nano® and Micro+Nano®. They reported employing plasma immersion ion implantation (PIII) treatment. Their recommended loading time was of 3 months in ideal clinical situations, based on clinical and laboratory studies conducted by the company. They made reference to six studies already published[10-15] and three others in press, all conducted with implants manufactured by the company, although only two of them investigated the factors discussed herein.

Titaniumfix® reported having hybrid surfaces resulting from abrasion and acid etching. Their machined implants go through aluminum oxide abrasion and are then passivated in nitric acid. The company could not provide further details due to business confidentiality. They recommend a loading time of 6 months for the maxilla and 4 months for the mandible, a loading time supported by findings in current literature. They made reference to nine studies[16-25] that used implants manufactured by their company, although only four investigated the factors discussed herein.

DISCUSSION

Implantology has unquestionably determined the superiority of rough-surface implants over machined ones.[25,26] The surface treatments that best promote cell response have been extensively investigated.

Analysis of surface topography revealed that Titaniumfix® and Neodent® use abrasion followed by acid etching, which, as found in SLA Straumann® implants, results in greater bone-implant contact (BIC) and greater

Table 1: Surface name, implant surface treatment, loading time, determining factors of loading time and scientific studies or publications about the surface treatment used by the companies analyzed in this study.

Company name	Surface name	Implant surface treatment	Loading time	Determining factors of loading time	Scientific studies or publications
Conexão	Porous and Vulcano Actives	Acid etching	1-2 months	Studies found in the literature	Shibli et al[4] Shibli et al[5] Shibli et al[6] Grassi et al[7]
Kopp	Chemical treatment	ABNT 12932	3-5 months	Clinical, surgical and product factors	Carvalho et al[8] Elias et al[9]
Neodent	Neoporos	Abrasion followed by acid etching	2-3 months	BIC – bone repair	-
P-I	Nano and Micro+Nano	PIII (*Plasma Immersion Ion Implantation*)	3 months	Clinical and laboratory studies conducted by the company	Barbosa et al[10] Canullo et al[11] Canullo et al[12] Francischone et al[13] Meirelles[14] Meirelles et al[15]
Titaniumfix	Hybrid surface resulting from abrasion and acid etching	Machined implants go through aluminum oxide abrasion and are then passivated in nitric acid	6 months for the maxilla and 4 months for the mandible	Loading time supported by findings currently found in the literature.	Correa et al[16] D'Avila et al[17] Duarte et al[18] Faeda[19] Neto[20] Ribeiro et al[21] Ribeiro et al[22] Sakakura et al[23] Tavares et al[24]

removal torque than when surfaces are machined.[27] Conexão® and Kopp® use total acid immersion, which results in greater removal torque than that found for machined implants.[28,29] P-I® uses plasma immersion ion implantation (PIII), a new process employed to modify surface implants, which results in greater removal torque than that found for machined surfaces.[15]

Conexão® recommended a loading time of 4 weeks for the Vulcano Actives surface, and more than 2 months for the Porous surface. The company made reference to four studies. In the first, mini-implants treated by abrasion and acid etching were placed in human maxillae and mandibles. After 2 months, the results yielded for implants with abraded and acid-etched surfaces were better than those of machined implants.[7]

Shibli et al[4] conducted a clinical case study in which an anodized and a machined implant were placed in the posterior mandible. The authors found a greater BIC percentage in the anodized implant 3 months after healing. They also developed a study comparing anodized and machine surfaces of mini-implants placed in human posterior maxilla, and found greater BIC and bone density in the thread area (BD) for the anodized group 2 months after healing.[5] A third study was conducted by the same authors with human mini-implants placed in the maxilla and mandible, and found greater BIC in anodized implants 2 months after healing.[6] All studies referred by Conexão® were conducted with the company's implants of which surfaces underwent anodization and abrasion combined with acid etching. However, the company claimed to use only acid etching. The recommended loading time is in agreement with what is suggested in the studies, but the type of surface described is not the same as the one reported in the questionnaire.

The studies referred by Kopp® were not conducted with their own implants, and were limited to evaluating implants with modified surface topography as well as machined implants.

Neodent® did not mention any studies conducted with their own implants.

P-I® recommends a loading time of 3 months. Although 6 studies were mentioned to justify that recommendation, only 2 actually discussed the factor. Canullo et al[11] conducted a study with 417 patients who received immediate loading implants or implants with loading time of 45 and 128 days. They found a survival rate of 96.64% for P-I® implants with subtraction treatment carried out by mechanical ultra cleaning, with no significant differences between survival rates in cases of early and late implant loading. Despite these results, the type of surface treatment used in the study was different from the one reported in the questionnaire. Another P-I® study included implants that underwent PIII, a process in which the implant is first cleaned with argon, followed by surface abrasion with a mix of inert gases, and oxygen implanted to form rutile. The implants were placed in the tibia and femur of rabbits and, one month after healing, removal torque was greater than in machined implants.[15] Both studies were conducted with implants manufactured by the company, but the type of treatment informed in the questionnaire was different from that used in the studies. In spite of that, the data reported in those studies gave support to the use of the recommended loading time. The other studies referred by the company evaluated a new biomaterial (NanoBone®) and did not discuss loading time.[12] They also evaluated the ideal nanotopography to optimize bone response to implants and the role of a collecting implant chamber.[10-13] The other studies referred are in press.

Titaniumfix® recommends a loading time of 6 months for the maxilla and 4 months for the mandible. They referred nine articles to justify the recommended loading time, but five of them did not discuss the factors discussed herein. D'Ávila et al[17] conducted a study with mini-implants placed in the posterior maxilla of smokers, and found greater BIC for implants that underwent abrasion and acid etching in comparison to machined implants. Tavares et al[24] developed a research with rabbit tibias and compared 4 treatment types: laser beam irradiation with and without hydroxyapatite coating (HA), abrasion combined with acid etching and machining. The implants were removed 8 weeks after placement, and the best removal torque was found in the group of implants that received laser beam irradiation and HA coating, followed by laser beam irradiation alone, abrasion combined with acid etching and machining. However, the surface treatment informed by the company was different from the best treatment found

in this study. Another study examined rabbit tibias 4, 8 and 12 weeks after placement and compared implants that received different surface treatments: laser irradiation, HA coating, abrasion combined with acid etching and machining. The best results were found for the implants with HA coating, and similar results were found for those that received laser irradiation and abrasion combined with acid etching, all superior to machined implants.[19] A clinical study evaluated an abraded and acid-etched implant 40 months after loading and found high levels of osseointegration.[23] The other studies referred by the company focused on different factors. Studies with implants subjected to aluminum oxide abrasion (AL_3O_2) found higher BIC values than that observed in machined implants.[21,22] A comparison of aluminum oxide abrasion and machining found that abrasion resulted in higher BIC. These studies evaluated surface treatments that were different from the one used by the company. The other studies evaluated implants treated with plasma nitridation[20] and bacterial adhesion to different implant surfaces and curets.[18] Although some studies found better tissue response of implants treated with abrasion and acid etching, which was the treatment used by the company, loading time was still defined according to the classical Brånemark protocol, developed for machined implants. Moreover, the studies referred by the company reported that other types of treatment had better results than abrasion and acid etching. The results of these studies reveal why the company has not yet recommended any reduction in loading time. All studies were conducted using implants manufactured by Titaniumfix®.

Little scientific evidence was provided by the companies included in this study, and most of the studies they made reference to did not deal with the factors discussed herein. In spite of that, no attempt was made to obtain further information after the questionnaire was returned, given that the central purpose of this study was to clarify whether Brazilian companies explain and provide scientific material to dentists in order to justify their clinical recommendations for surface treatment and osseointegration.

Some scientific studies did not include the companies' own implants, and studies with implants manufactured by other companies were used to justify their recommended loading time. Furthermore, although some companies had a few scientific studies that included their own products, the results were not used to recommend loading time for their implants. Therefore, our findings suggest that the companies included in this study do not follow scientific evidence of ideal loading time for their recommendations. A recent study compared roughness resulting from surface treatment of five of the most important Brazilian implant brands (Biomet 3i do Brasil, Conexão, Neodent, SIN and Titaniumfix) and of world-reference implant surfaces (Straumann – SLA®, Biomet 3i – Osseotite® and Nobel Biocare – TiUnite®), for which there is extensive scientific documentation. The results of Brazilian implants were different, although the manufacturing processes were similar. Most implants had a low roughness index, as well as statistical differences between batches. These results suggest that Brazilian companies should consider re-assessing their surface treatment processes.[30]

CONCLUSION

Although some companies conduct scientific studies with their own implants, this study found that there was no scientific evidence to support the recommended loading times, and that instructions given to dentists are not accurate. Further contact with those companies should be attempted to investigate whether the recommended protocols are supported by findings of other in-house studies.

References:

1. Branemark PI, Adell R, Breine U, Hansson BO, Lindstrom J, Ohlsson A. Intra-osseus anchorage of dental prostheses. I. Experimental studies. Scand J Plast Reconstr Surg. 1969;3(2):81-100.
2. Buser D, Schenk RK, Steinemann S, Fiorellini JP, Fox CH, Stich H. Influence of surface characteristics on bone integration of titanium implants. A histomorphometric study im miniature pigs. J Biomed Mater Res. 1991;25(7):889-902.
3. Davies JE. Mechanisms of endosseus integration. Int J Prosthod. 1998;11:391-401.
4. Shibli JA, Feres M, Figueiredo LC, Lezzi G, Piattelli A. Histological comparison of bone to implant contact in two types of dental implant surfaces: a single case study. J Contemp Dent Pract. 2007;8(3):29-36.
5. Shibli JA, Grassi S, Figueiredo LC, Feres M, Lezzi G, Piattelli A . Human peri-implant bone response to turned and oxidized titanium implants inserted and retrieved after 2 months. Implant Dent. 2007;16(3):252-9.
6. Shibli JA, Grassi S, de Figueiredo LC, Feres M, Marcantonio E Jr, Iezzi G, et al. Influence of implant surface topography on early osseointegration: a histological study in human jaws. J Biomed Mater Res B Appl Biomater. 2007;80(2):377-85.
7. Grassi S, Piattelli A, de Figueiredo LC, Feres M, de Melo L, Iezzi G, et al. Histologic evaluation of early human bone response to different implant surfaces. J Periodontol. 2006;77(10):1736-43.
8. Carvalho BM, Pellizzer EP, Moraes SLD, Falcón-Antenucci RM, Ferreira Júnior, JS. Tratamento de superfície nos implantes dentários. Rev Cir Traumatol Buco-maxilofac. 2009;9(1):123-30.
9. Elias CN, lima JHC, Meirelles LAD. Variação da osseointegração com a rugosidade dos implantes odontológicos. In: 1º Simpósio Matéria 2000, Rio de janeiro; 2000. p. 1-9.
10. Barbosa BA, et al. Efeitos microscópicos da ação da câmara coletora do implante no tecido ósseo: mecanismo para favorecer a osseointegração: nota prévia. ImplantNews. 2009;6(4):431-2.
11. Canullo L, Cicchese P, Sisti A, Francischone Jr CE, Francischone CE, Vasconcelos LW, et al. Análise clínica retrospectiva (4-6 anos) dos implantes P-I Brånemark Philosophy™. ImplantNews. 2009;6(5):517-24.
12. Canullo L, Dellavia C, Heinemann F. Maxillary sinus floor augmentation using a nano-crystalline hydroxyapatite silica gel: case series and 3-month preliminary histological results. Ann Anat. 2012;194(2):174-8.
13. Francischone CE, et al. The role of the collecting implant chamber: histological and histomorphometric study in minipigs. ImplantNews. 2011;8:123.
14. Meirelles L. Nanoestruturas e a resposta óssea. Uma alternativa segura para a reabilitação com implantes osseointegráveis? ImplantNews. 2010;6(7):169-72.
15. Meirelles L, Uzumaki ET, Lima JHC, Muller CA, Albrektsson T, Wennerberg A, et al. A novel technique for tailored surface modification of dental implants. A step wise approach based on plasma immersion ion implantation. Clin Oral Implants Res. 2013;24(4):461-7.
16. Correa MG, Campos MLG, César-Neto JB, Casati MZ, Nociti FH, Sallum EA. Histometric evaluation of bone around titanium implants with different surface treatments in rats exposed to cigarette smoke inhalation. Clin Oral Implants Res. 2009;20(6):588-93.
17. D'Ávila S, Reis LD, Piattelli A, Aguiar KCS, Faveri M, Borges FL, et al. Impact of smoking on human bone apposition at different dental implant surfaces: a histologic study in type IV bone. J Oral Implantol. 2010;36(2)85-90.
18. Duarte PM, Reis AF, de Freitas PM, Ota-Tsuzuki C. Bacterial adhesion on smooth and rough titanium surfaces after treatment with different instruments. J Periodontol. 2009;80(11):1824-32.
19. Faeda RS. Avaliação de implantes de titânio com modificação da superfície por ablação a laser ou recobrimento por hidroxiapatita biomimética. Estudo biomecânico em tíbia de coelhos [dissertação]. Araraquara (SP): Universidade Estadual Paulista; 2006.
20. Guerra Neto CLB. Avaliação da Osseointegração de Implantes de Ti Nitretados em Plasma [tese]. Natal (RN): Universidade Federal do Rio Grande do Norte; 2005.
21. Ribeiro FV, Casarin RCV, Nociti Jr FH, Sallum EA, Sallum AW, Casati MZ. Efeito do tratamento de superfície de Implantes sobre o reparo ósseo – estudo histométrico em ratos. Periodontia. 2006;16(2):42-9.
22. Ribeiro FV, Nociti Jr FH, Sallum EA, Casati MZ. Effect of aluminum oxide–blasted implant surface on the bone healing around implants in rats submitted to continuous administration of selective cyclooxygenase-2 inhibitors. Int J Oral Maxillofac Implants. 2009;24(2):226-33.
23. Sakakura CE, Nociti Jr FH, Mello GPS, Mello EDA, Rezende MLR. Histomorphometric evaluation of a threaded, sandblasted, acid-etched implant retrieved from a human lower jaw: a case report. Implant Dent. 2005 ;14(3):289-93.
24. Tavares HS, Faeda R, Guastaldi AC, Guastaldi FPS, Marcantônio Jr E. Study on implants subjected to four different surface treatments by SEM-EDS and biomechanical test. J Osseointegr. 2009;1:15-21.
25. Buser D, Nydegger T, Oxland T, Cochran DL, Schenk RK, Hirt HP, et al. Interface shear strength of titanium implants with a sandblasted and acid-etched surface: a biomechanical study in the maxilla of miniature pigs. Biomed Mater Res. 1999;45(2):75-83.
26. Hermann JS, Buser D, Schenk RK, Schoolfield JD, Cochran DL. Biologic Width around one- and two-piece titanium implants. Clin Oral Implants Res. 2001;12(6):559-71.
27. Abrahamsson I, Berglundh T, Linder E, Lang NP, Lindhe J. Early bone formation adjacent to rough and turned endosseous implant surfaces. An experimental study in the dog. Clin Oral Implants Res. 2004;15(4):381-92.
28. Baker D, London RM, O'Neal R. Rate of pull-out strength gain of dual-etched titanium implants: a comparative stud in rabbits. Int J Oral Maxillofac Implants. 1999;14(5):722-8.
29. Hsu S, H. Liu BS, Lin WH, Chiang HC, Huang SC, Cheng SS. Characterization and biocompatibility of a titanium dental implants with a laser and dual-acid etched surface. Biomed Mater Eng. 2007;17(1):53-68.